Service Manual

for the

Cranex Novus Dental X-ray Unit

200569 rev. 4 (2011-09)

Service Manual for the Cranex Novus Dental X-ray Unit

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1. General Information

1.1 Introduction

This manual describes how to service all versions of the Cranex Novus and OEM versions of the Cranex Novus.

1.1 Associated documentation

The Cranex Novus User's manual.
The Cranex Novus Installation manual.
The Cranex Novus Spare-parts manual.

1.2 Service precautions and warnings

Servicing precautions

Only service personnel trained and approved by Soredex are allowed to service the Cranex Novus.

Before attempting to service the device make sure that you know how to operate it. Read the Cranex Novus User's Manual.

Read and familiarize yourself with the warnings and precautions listed in the Cranex Novus User's Manual.

Only use original Soredex spare parts when repairing the device or replacing parts.

The device is factory set to operate using **either** a 230VAC power supply **or** a 115VAC power supply. Never connect the device to a power supply different to the voltage marked on the device.

Warning - Radiation Safety

Before servicing the device familiarize yourself with local and national radiation safety standards and requirements relating to dental x-ray equipment.

When taking test exposures take adequate precautions to protect yourself from radiation. Stand behind a suitable radiation shield positioned at least two metres (six feet) from the unit.

Warning - Mechanical safety

Disconnect the device from the main power supply before removing any covers.

Disconnect the device from the main power supply before repairing or replacing mechanical parts or installing accessories.

Be careful when operating the device not to get body parts or clothing trapped between moving parts.

During operation some surfaces and components may become hot. Take precautions to avoid burning yourself.

The aperture plate in the collimator is made of lead (Pb) which is toxic. Do not touch it with your bare hands.

Do not open the tubehead. There are no serviceable parts, mechanical or electrical, inside the tubehead.

Warning - Electrical Safety

Disconnect the device from the main power supply before replacing circuit boards or other electrical components.

If there are capacitors on a circuit board or electrical component wait ten (10) minutes, after disconnecting the device from the power supply, before handling the board or component.

If you have to leave the device unattended during servicing or maintenance, disconnect the unit from main power supply to protect people, who may touch the unit, from electric shock.

This device should be used only in areas that are provided with a protective earth connection to ensure an equipotential ground connection.

Caution - electrostatic discharge

Electrostatic Discharge (ESD) can damage or destroy electronic components.

When servicing the device take precautions to avoid electrostatic build up and discharge (ESD). Follow the recommendations for the prevention of ESD that are used in the country in which you are working. If no recommendations are available, follow the guidelines below:

- Leave all new or replacement circuit boards and electrical parts in their protective packaging until the boards are needed.

- Before handling circuit boards and electrical parts make sure that any static electricity charge that has built up in you body is discharged.

- When examining and checking circuit boards use an antistatic wrist wrap which is connected to a ground point through a 1 Mohm current limiting cable. For a ground point use water pipes, radiators or other objects that are known to be connected to the ground. Also use a cable to connect the unit to the same ground potential as the wrist wrap.

- When handling circuit boards hold them by their edges and do not touch any components or connectors.

- If an antistatic mat is used, connect the wrist wrap to the mat and the mat to the ground potential.

- Wash the wrist wrap and check that it is in good condition frequently.

Warning - Explosion hazard

Certain disinfectants and cleaning agents may vaporize to form an explosive vapour. If such chemicals are used the vapour should be allowed to disperse before switching the device on.

Warning - Cleaning the unit

Switch the unit off and disconnect it from the main power supply before cleaning or disinfecting the unit.

1.3 Unauthorized Modifications

Unauthorized changes or modifications to any part of the unit or its equipment can have hazardous consequences. Changes or modifications must not be made unless specifically authorized by Soredex.

When properly assembled with a compatible beam-limiting device, the diagnostic source assembly will fully meet the United States of America Federal Performance Standards for Diagnostic X-Ray Systems and Their Components (21 CFR 1020. 30-32) provided no components or parts are removed from the unit and no unauthorized adjustments are made to the beam-limiting device or tube housing assembly.
Never remove or remanufacture any part of the tube housing assembly or beam-limiting device.
Never adjust any part of the beam-limiting device unless under the direction of Soredex or their authorized distributor.

1.4 Disclaimer

Soredex shall have no liability for consequential damages, personal injury, loss, damage or expense directly or indirectly arising from the use of its products. No agent, distributor or other party is authorized to make any warranty or other liability on behalf of Soredex with respect to its products.

1.5 Yearly maintenance

The following tests and inspections must be carried out annually by an authorized service person to verify that the device meets the specifications and performance criteria essential for correct and safe operation.
When taking measurements that require a multimeter, always use a digital multimeter (DMM).

kV test

WARNING: X-rays are generated when this test is carried out. PROTECT YOURSELF FROM RADIATION.

1. Connect the +probe of a DMM to test pin TP14 (kVfb) and the -probe to TP17(GND) on the Generator board.

2. Select service command **exp** and an exposure time of 2000 ms (refer to section 4 Service assistant and service functions, in this manual).

3. Protect yourself from radiation and take an exposure. Check the feedback values from the DMM. The feedback values must be within the tolerances.

Selected kV	kVfb	Tolerance (V)
60	3.0	±0.2 (2.8 - 3.2)
70	3.5	±0.2 (3.3 - 3.7)

If the values are not within the tolerances, recalibrate the Generator board, see section 5.2 Service Commands (the **calib** command).

mA test

WARNING: X-rays are generated when this test is carried out. PROTECT YOURSELF FROM RADIATION.

1. Connect the +probe of a DMM to test pin TP18 (mAfb) and the -probe to TP17(GND) on the Generator board.

2. Select service command **exp** and an exposure time of 2000 ms (refer to section 4 Service assistant and service functions, in this manual).

3. Protect yourself from radiation and take an exposure. Check the feedback values from the DMM. The feedback values must be within the tolerance.

Selected mA	mAfb (V)	Tolerance (V)
7	2	±0.2 (1.8 - 2.2)

If the value is not within the tolerance, recalibrate the Generator board, see section 5.2 Service Commands (the **calib** command).

Beam alignment test

Check the beam alignment. Refer to the Installation and set-up manual for information on how to do this.

Ground test

Disconnect the unit from the main power supply before carrying out this test.
Check the safety ground continuity by measuring the grounding resistance between the ground pin on the connector of the mains power supply cable and any metal part of the unit.
The resistance MUST be <0.2 ohm.

Motor movements

Switch the unit off and then manually rotate the rotating unit to check that all the stepper motor moves freely and without any looseness.

Switch the x-rays off and then take an exposure to check that the motors operate smoothly and without any noise.

Press the up/down keys to check the Z-motor (vertical carriage movement). The motor must operate smoothly and without any noise.

Position detectors

Press the up key and drive the unit up. Make sure that the unit stops moving at its uppermost position.
Press the down key and drive the unit down. Make sure that the unit stops moving at its lowermost position.

Use service command **optotest**, see section 5.2 Service Commands, to check the rotating unit optosensors.

Patient Positioning Lights

Check that the patient positioning lights work and are positioned correctly. Refer to the Installation and set-up manual for information on how to do this.

Mains power supply cable

Check the condition of main power supply cable and replace it if damaged.

Tubehead

Make sure that oil is not leaking from the tubehead. If the tubehead shows signs of oil leakage, replace it.

Covers and Labels

Check that all covers are correctly installed and in good condition. Also check that all the labels are attached to the unit and that they are all legible.

Fire risk

WARNING: Disconnect the unit from the main power supply before carrying out the next task.
Use a vacuum cleaner to remove all dust that has accumulated inside the unit to eliminate the risk of fire.

1.6 Disposal

At the end of useful working life of the device, its spare and replacement parts and accessories make sure that you follow all local, national and international regulations regarding the correct and safe disposal and/or recycling of the device, its spare and replacement parts and accessories.

The device and its spare parts and accessories may include parts that are made of or include materials that are non-environmentally friendly or hazardous. These parts must be disposed of in accordance with all local, national and international regulations regarding the disposal of non-environmentally friendly or hazardous materials.

The following hazardous materials and substances can be found in the device, its spare and replacement parts and assemblies:

- Lead (Pb): circuit boards, tubehead.
- Cadmium (Cd): none
- Mercury (Mg): none
- PBB Polybrominated biphenyls: none
- PBDE polybrominated diphenyl ethers: none

Other materials and substances in the device, its spare parts and assemblies that could be hazardous and are non-environmentally friendly are:
- Phosphor: beam alignment tools
- Mineral oil: tubeheads

The locations of all the device parts, spare and replacement parts and assemblies listed above can be found in the device service and/or installation manual.

2. Unit description

2.1 The Cranex Novus

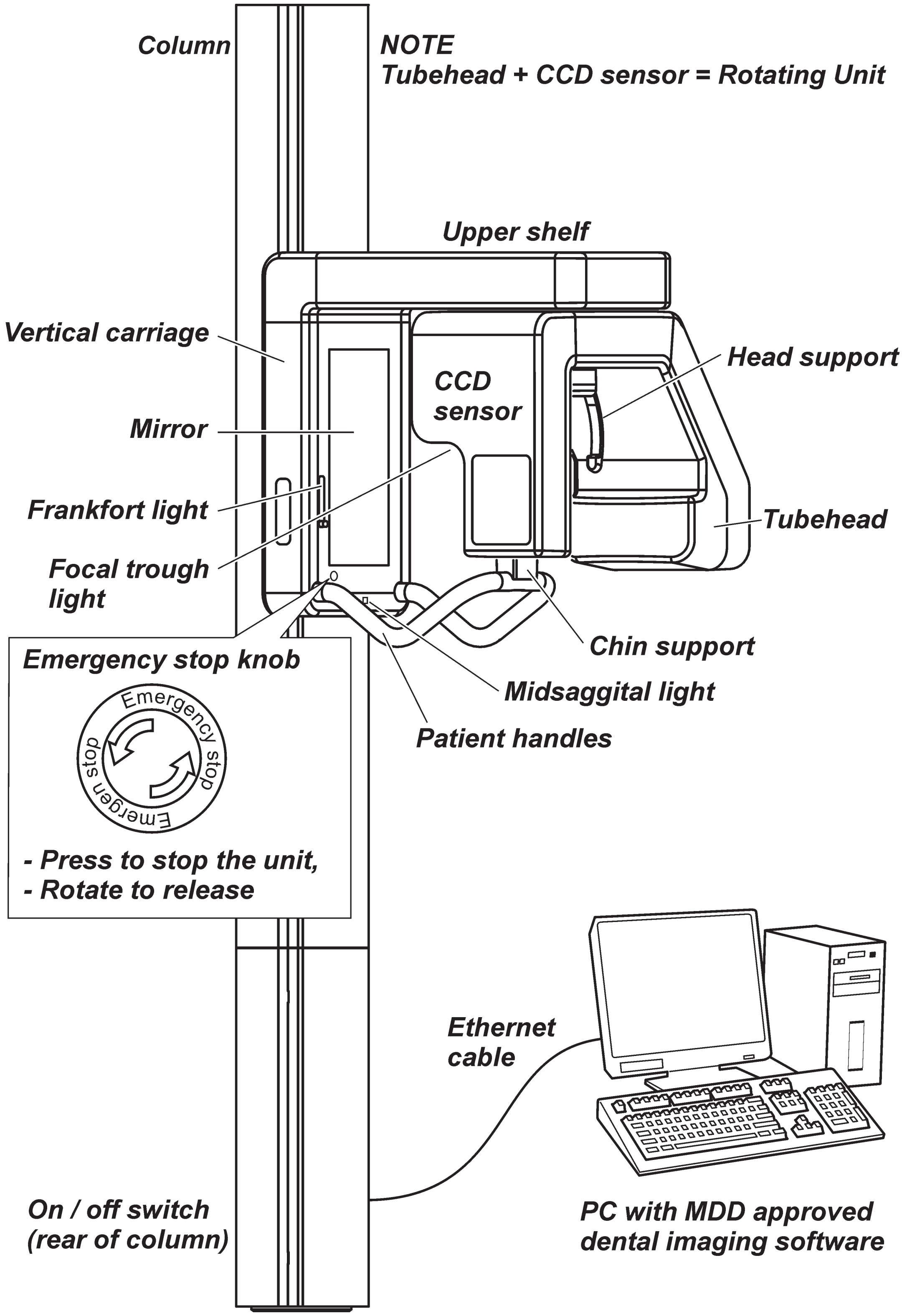
The Cranex Novus digital extraoral x-ray unit is designed to take exposures of the dento-maxillofacial region.
The units cannot be used to take x-ray exposures of any other part of the human anatomy.

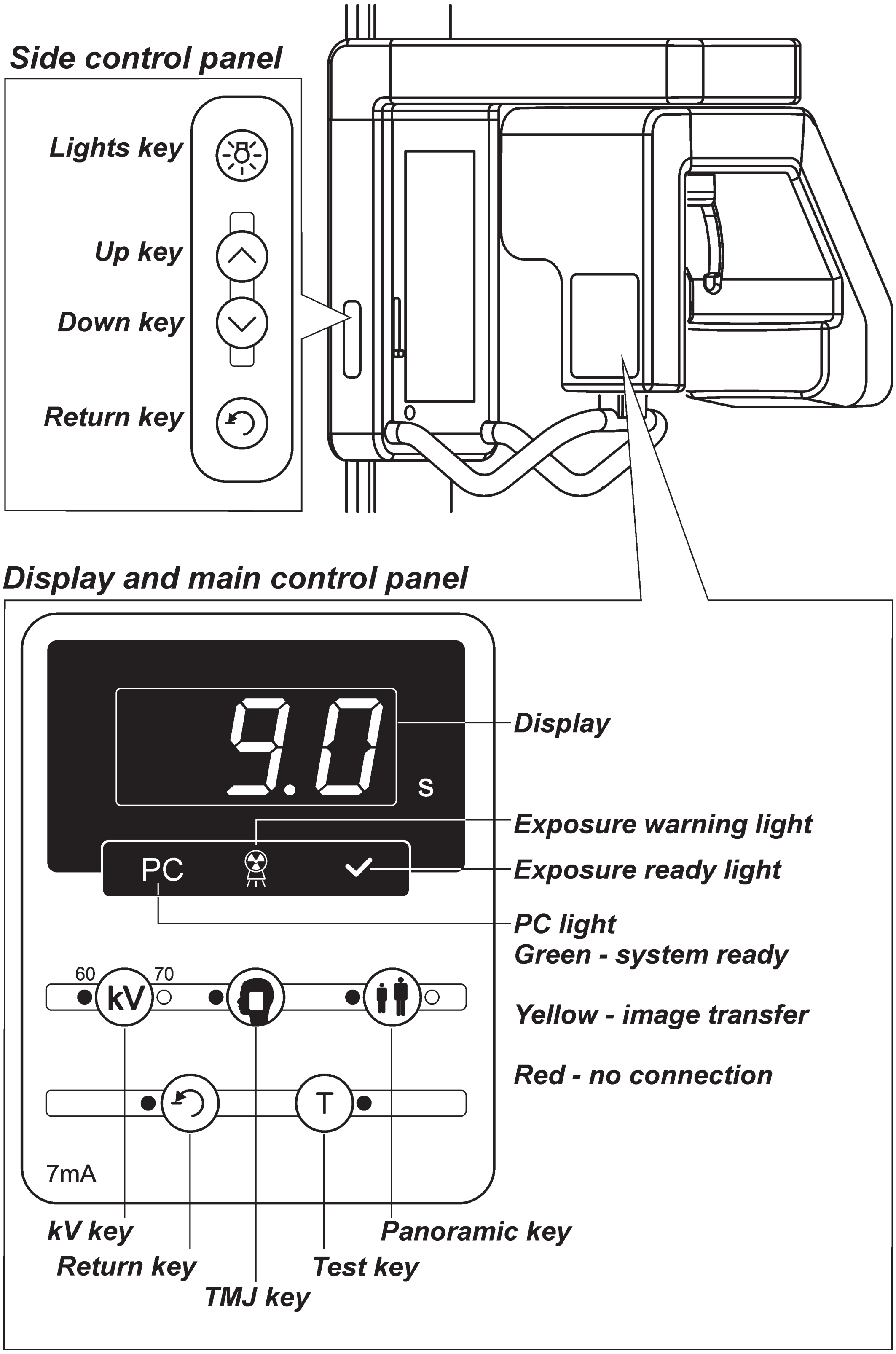
The Cranex Novus can be used to take adult panoramic (full width), child panoramic (reduced width) and TMJ images.

All units are factory set to operate using **either** a 230 VAC power supply **or** a 115 VAC power supply.
The voltage setting CANNOT be changed.

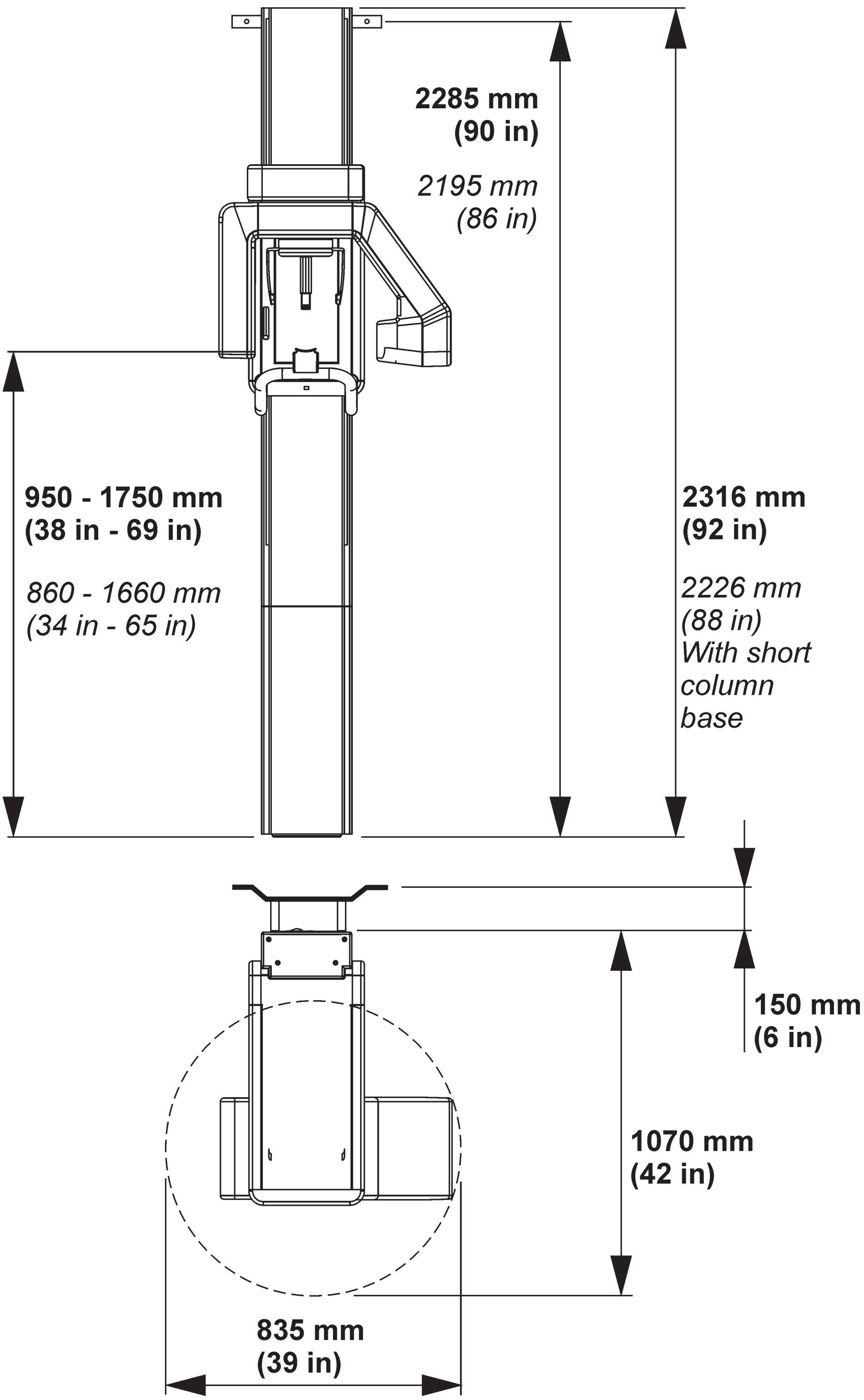
The Cranex Novus is used with a PC in which Digora for Windows or some other MDD approved dental imaging software is installed.

2.2 The main parts and assemblies




Side control panel
Lights key
Up key
Down key
Return key
Display and main control panel
9.0
s
PC
Display
Exposure warning light
Exposure ready light
PC light
Green - system ready
Yellow - image transfer
Red - no connection
60
70
kV
T
7mA
kV key
Return key
TMJ key
Test key
Panoramic key

2.3 Unit dimensions



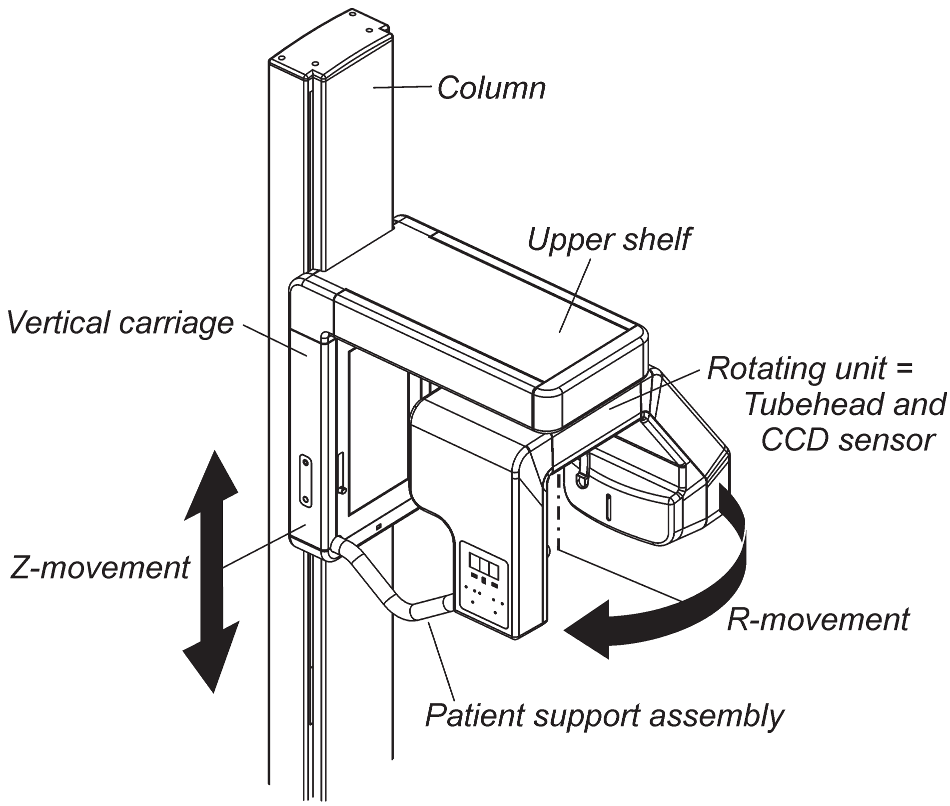
2.4 Mechanical description

The unit comprises a **column**, a **vertical carriage**, an **upper shelf**, a **rotating unit** and a **patient support assembly**.

The **column** rests on the floor and is fixed to the wall using wall bracket. If the unit is used in areas prone to earthquakes the base of the **column** MUST also be fixed to the floor.
If the unit needs to be free standing it can be attached to the show stand (part no. 9802666).

The **vertical carriage** is attached to the **column** and can slide up and down the **column** (Z-movement, for unit height adjustment). The **upper shelf** is attached to the top of the **vertical carriage**.

The **rotating unit**, which comprises the tubehead and collimator and the **CCD sensor** assembly, is attached to the underside of the upper shelf. The **rotating unit** rotates to take panoramic exposures (R-movement).

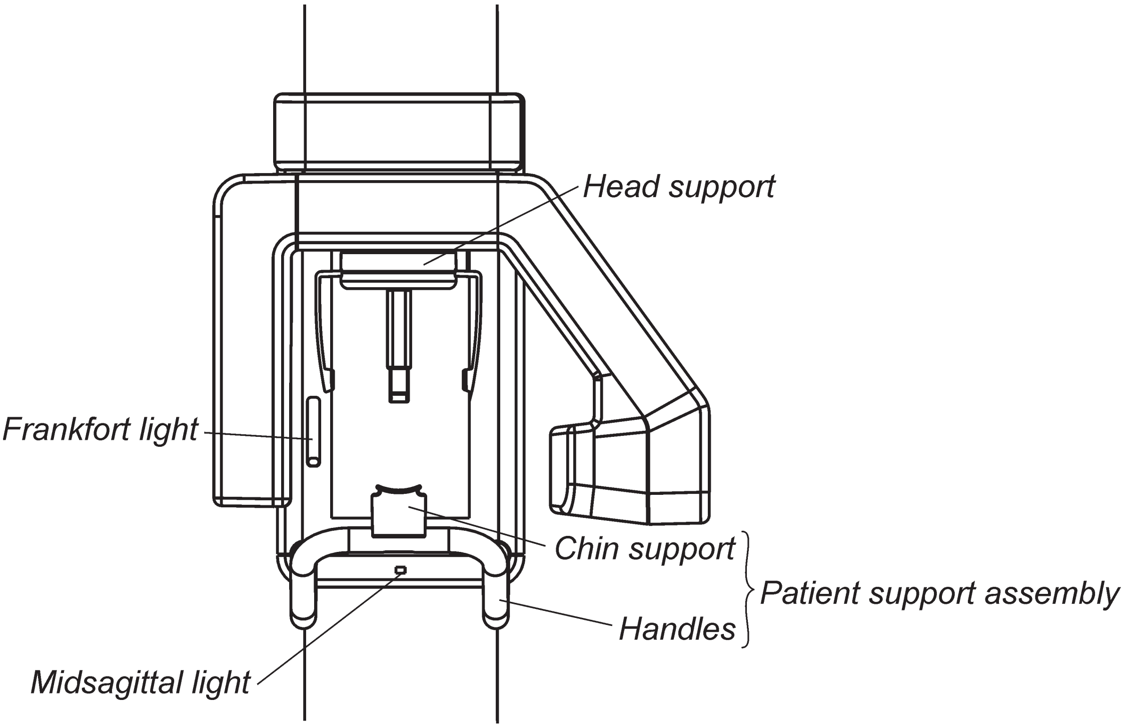


Inside the **tubehead** there is the x-ray tube. It is a fixed tungsten anode type with a focal spot of 0.5 mm. The maximum anode voltage is 70kV and maximum current is 7mA.

The **patient support assembly** is attached to the bottom of the vertical carriage. It comprises **handles** for the patient to hold and a chin support.

The patient is held in position with a four-point support system. The **head support** (attached to the rotating unit) supports the patient's head with temple supports and the forehead support. The **patient support assembly** supports the patients lower jaw on the chin support, using either the chin rest or lip support.

There are two patient positioning laser lights, **midsagittal light** and **Frankfort (horizontal) light**.



2.5 Electrical description

Circuit boards

Circuit boards are described in detail in section **3. Circuit Boards**.

Power supply

Power (230VAC or 115VAC) is supplied to the unit through L100 (Z-Motor Driver). From L100, power is routed through the Generator board to a transformer which produces low voltages (+3, +3.3, +5, -9.4, +15 and +24V) that are supplied to L200, a linear mode power supply, which distributes the voltages to the other boards in the unit. The transformer also produces 27VAC and 19VAC voltages that are supplied directly (not through L200) to the Generator board.

The power for the AC-motor (z-motor), 230VAC or 115VAC, is taken directly from L100 and not from the Generator board.

Capacitors on the Generator board produce the 310V needed to power the tubehead from the 230VAC or 115VAC supplied by L100.

Main fuses

Two 5AT/230VAC or 8AT/115VAC, dimensions 5mm x 20mm, UL approved.
They are located below the main power supply cable at the rear of the column.

Unit control

The unit is controlled by a microprocessor on L400 (CPU board). It continually monitors and controls the operation of the unit. A serial peripheral interface communication protocol (SPI - RS485) and direct digital I/O are used to monitor most of the unit functions.
The microprocessor:
- monitors the optosensors
- monitors control panel keys
- controls unit movements during exposures
- starts, controls and stops x-ray generation
- controls the digital imaging chain

The necessary unit settings and parameters for all the imaging programs are stored in the memory which is also on L400.

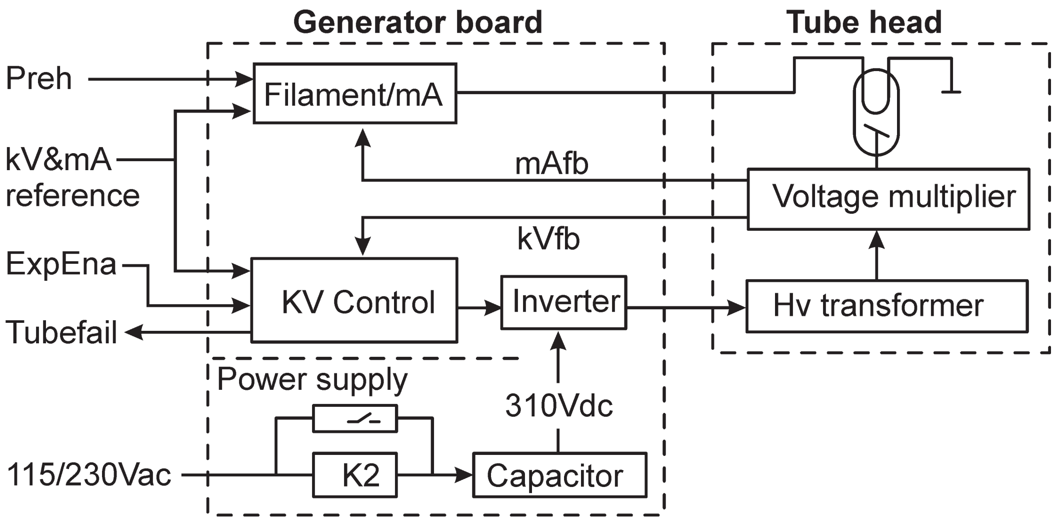
Motors and motor control

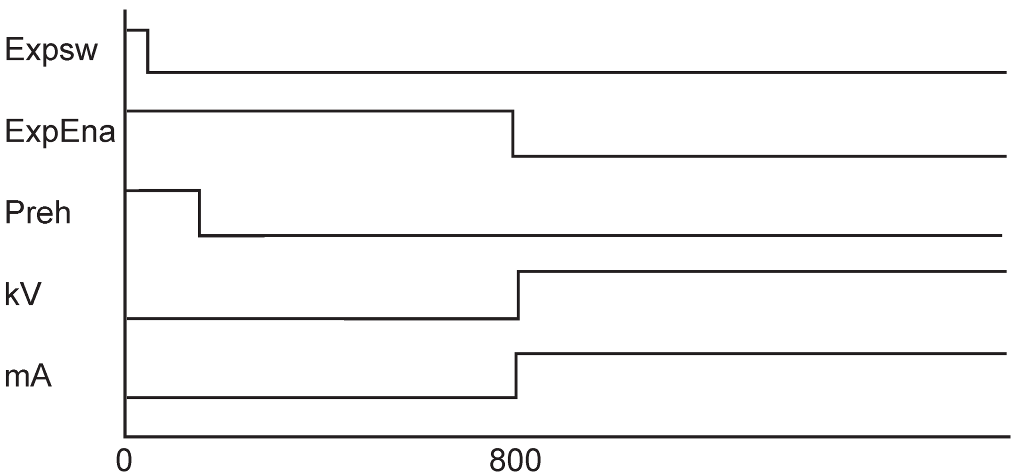
There is one stepper motor and one AC-motor in the unit.
The stepper motor drives the rotating unit (R-movement). The stepper motor is driven and controlled by L300 (3-Phase Microstepper Driver).

The AC-motor (Z-motor) adjusts the height of the unit (Z-movement), and the motor is activated by L100. To activate the Z-motor L100 must receive a control signal from L400 and a separate control (enable) signal from the Z-movement (up/down) keys.
An emergency switch on the front of unit disables the Z-motor (Z-movement) and stepper motor (R-movement) when pressed.

Exposure logic

An exposure can only be taken when the unit is in the ready state (the exposure ready light on the control panel is on) and the exposure button is pressed and held down.
The Generator board receives the correct kV and mA references from the CPU (L400). A few milliseconds after the exposure button is pressed (Expsw) preheat is enabled (Preh). After 800ms the exposure will start (ExpEna). The tubehead will receive power from the Generator board and the Generator board will also start to regulate the mA and kV according to mA- and kV-feedback.





Position control

The position of the rotating unit (R-movement) is monitored by optosensors on N2500 (Rotation Position Sensor Circuit). The optosensors indicate in which sector the rotating unit is. The optosensors ensure that the rotating unit is in the correct position, start or PIO (Patient In/Out), for an exposure.
The statuses of the optosensors are monitored continually by the unit software.

The upper and lower limits of the vertical carriage (Z-movement) are monitored by microswitches.

A overview of the Imaging Chain

This description assumes that the unit is ready to take an exposure.

Image acquisition is controlled by a software component, **D**igora **S**oftware **D**river (DSD) which is installed in the PC connected to the unit.

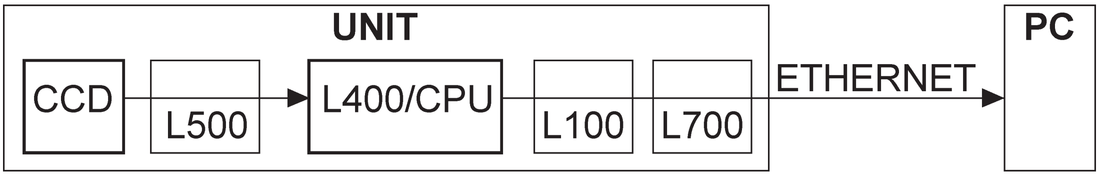
When an exposure is taken L400 (the CPU) then sends a PPOWER (pan) and CCDON signal. CCDON signal activates linear regulators on L200 which then produce the power supply voltages for the CCD sensor.

The CPU's control software continuously monitors the status of the connection with the DSD driver. After image exposure but before image transfer the CPU sends a label that includes the imaging parameters (—kV/—mA/ —s) and an imaging program identifier.

The CPU enables the IMAGE signal to activate pixel clocking. The CPU then produces the TDI clock signal, which clocks the pixels from the CCD sensor. Derivation of several CCD clock signals from the TDI clock is done by the CCD sensor board.

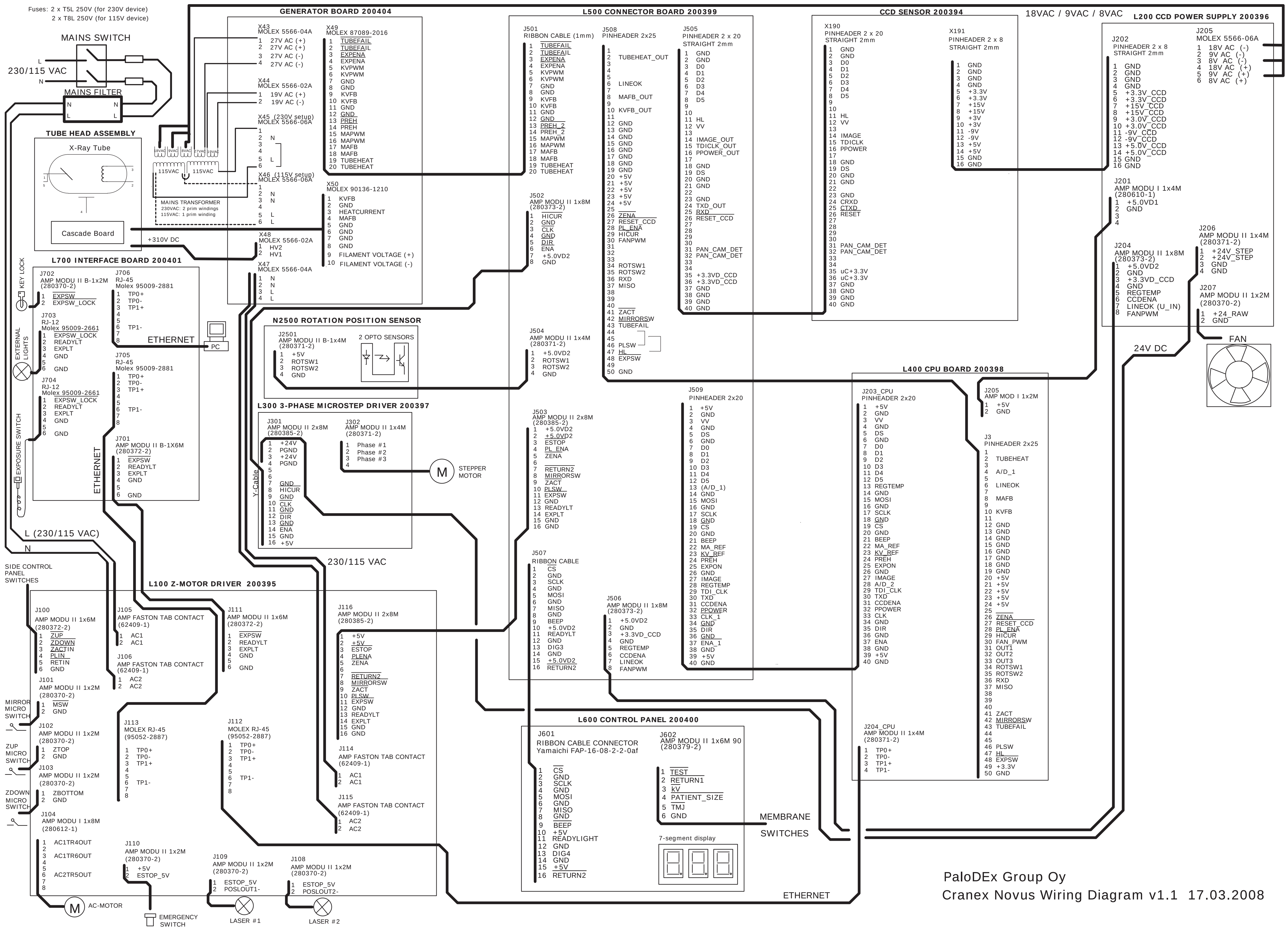
Radiation striking the CCD sensor is converted to visible light which is detected by the CCD cell. A binning procedure is carried out on individual pixels, i.e. two adjacent pixels in a row and column (2 x 2 binning) forms one large pixel (96µm x 96µm). The output voltage of the CCD is fed to a 14-bit A/D converter.

The CCD sensor board sends the image data (now 12 bits) to the CPU board where they are saved on the SDRAM. The image information is transferred to the PC via the Ethernet cable.

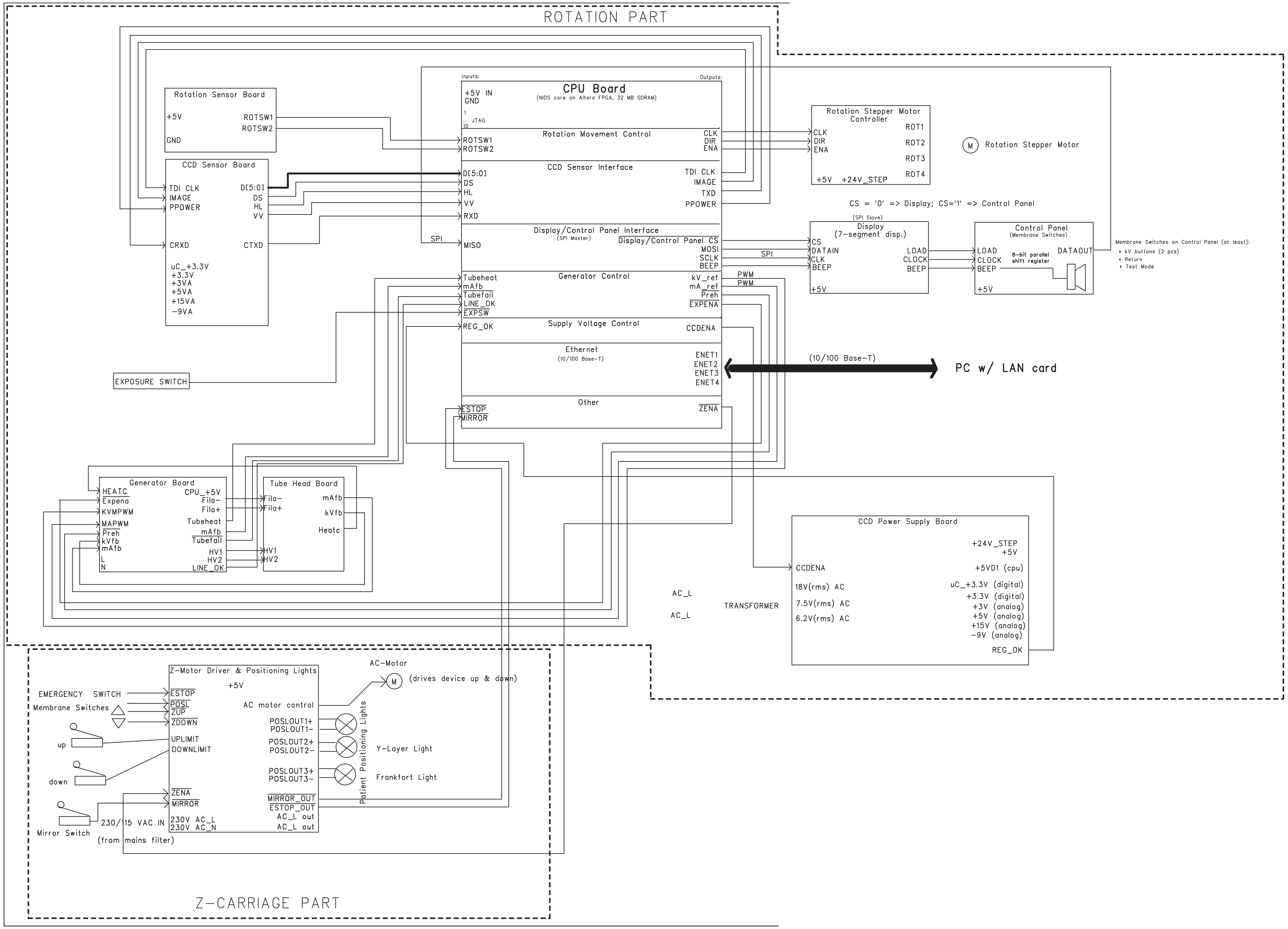


In the PC there is a Network Interface Card (NIC). After image data transfer the DSD preprocesses the raw image, for example it interpolates gaps between CCD chips, and carries out dark current correction and gain correction (the pixels do not have equal characteristics).

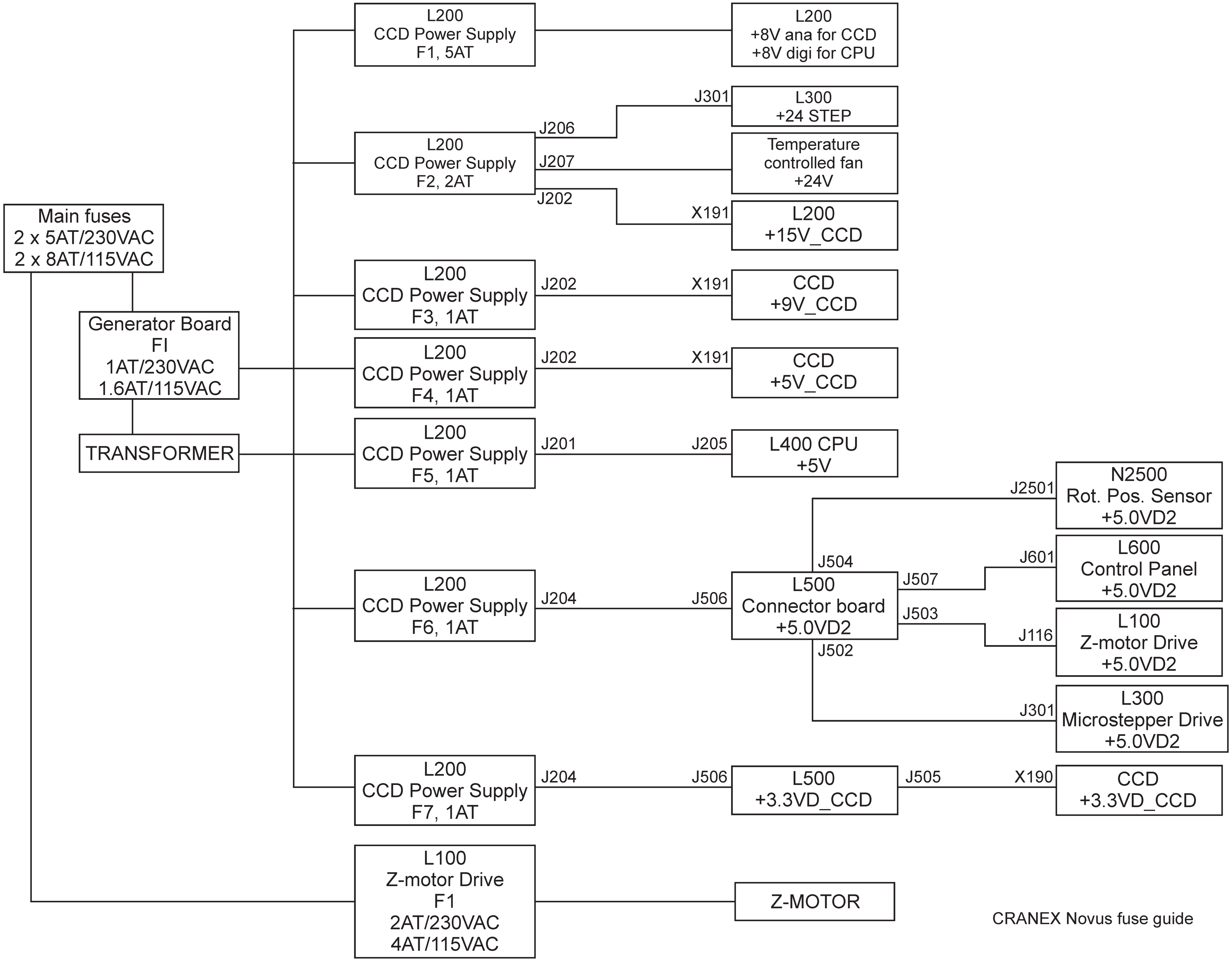
2.6 Wiring diagram - overview



2.7 Block diagram



2.8 Fuse diagram



CRANEX Novus fuse guide

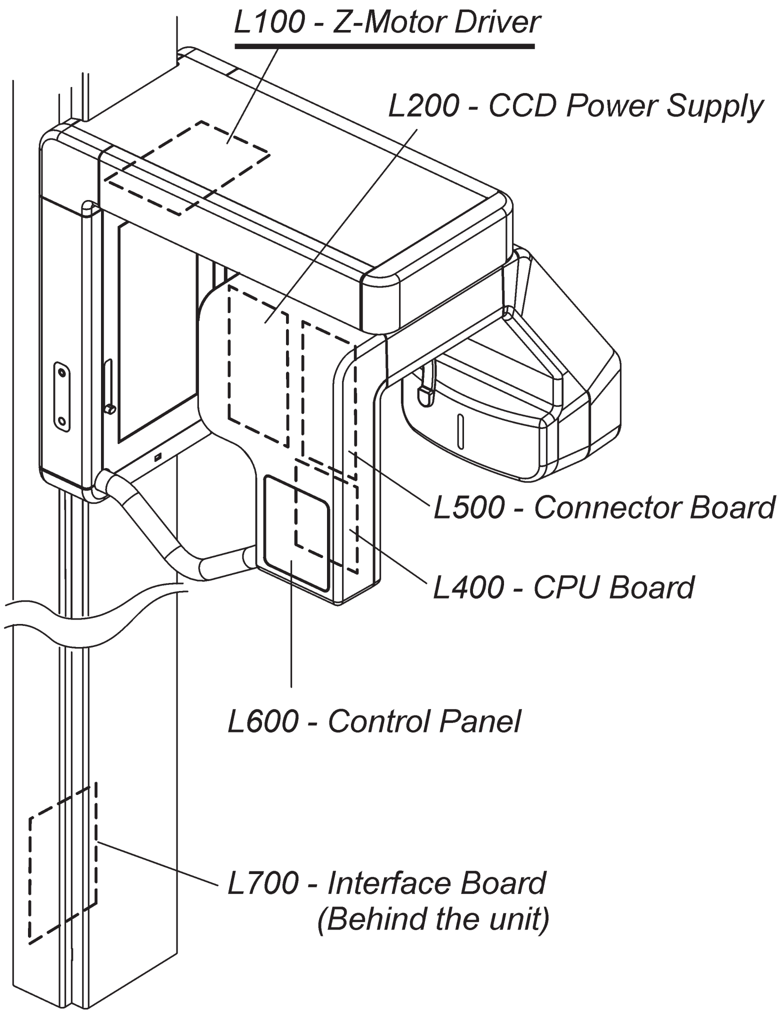
3. Circuit Boards

NOTE: An asterisk (*) after a signal name indicates an active low-level signal.

3.1 L100, Z-Motor Driver (Pt. no. 200395)

L100 - Location

On the upper shelf.
To access remove front panel and then top cover plate (see section 7.1).



L100 - Field replaceable parts

Fuse F1.

NOTE:
The fuses used MUST be the approved type, UL listed and CSA certified.

Approved fuses:
- for units rated 230VAC:
2AT/250VAC Cooper Bussmann MDL-2
or SIBA ELU 70 065 65.

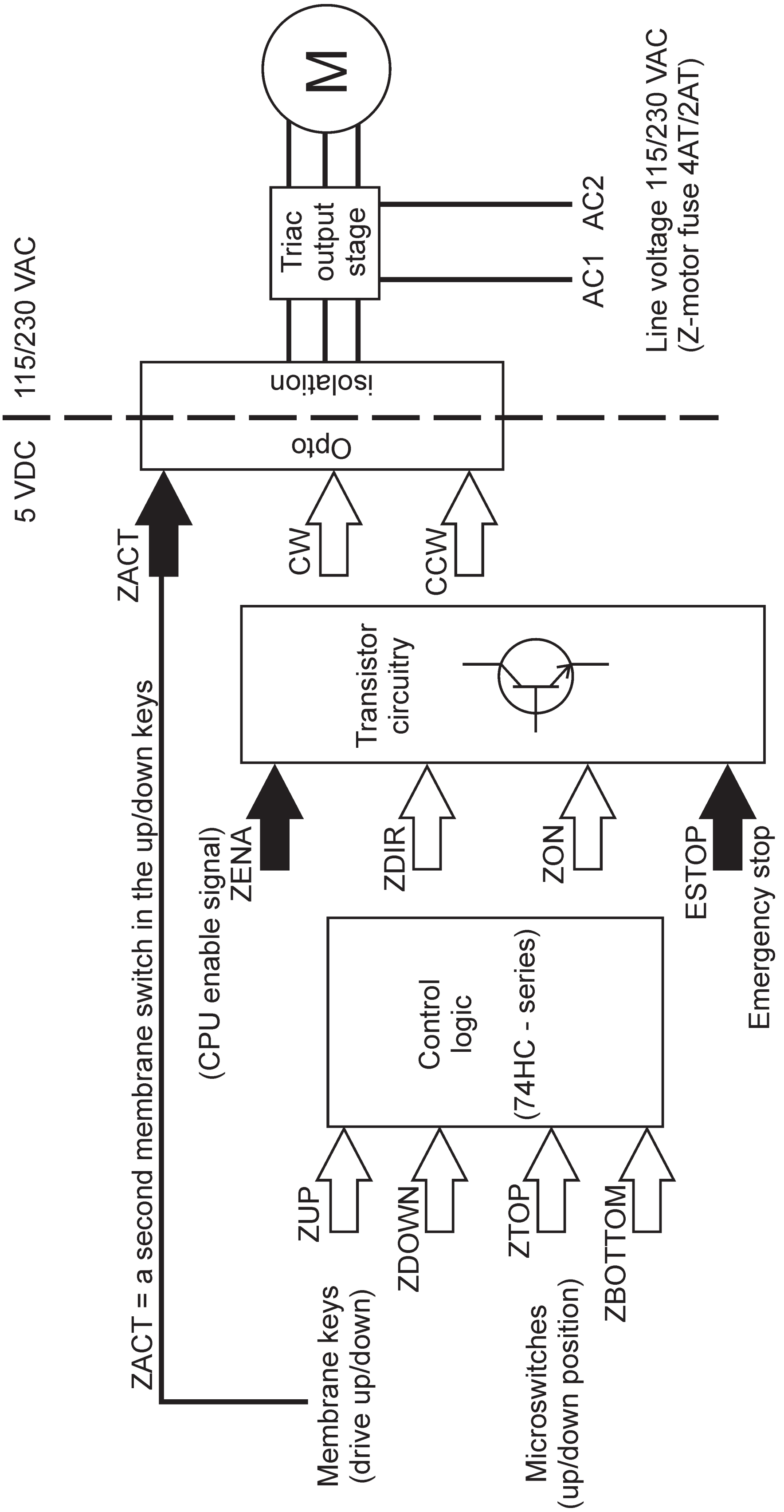
- for units rated 115VAC:
4AT/250VAC Cooper Bussmann MDL-4
or SIBA ELU 70 065 65.

Dimensions 6.3 mm x 32 mm.

L100 - Description

L100 (Z-motor Driver) controls the AC-motor that drives the unit up and down. Membrane switches on the side of the vertical carriage are used to activate the AC-motor. The positions of the Z-carriage and the Rotating Unit are also monitored by L100.
Micro switches at the top and bottom of the column monitor the upper and lower positions of the Z-movement. Based on the logic on the circuit board, the movement of the AC motor is enabled or prohibited. Three triacs control the Z-motor currents. Outputs are opto-coupled from the user inputs with TLP3063 circuits. The board also includes light controls for the laser positioning lights.

L100 - Block diagram



L100 - Block diagram

L100 - Indicator lamp

Lamp	Function	Indicates
LA1 GLIM	AC indicator lamp	L100 receiving 230 or 115VAC line voltage.

L100 - Indicator LEDs

LED	Colour	Indicates
D1	green	+5V on
D2	green	ZACT-movement key pressed
D3	green	ZON on
D4	red	ESTOP on. Emergency stop button is on.

L100 - Test Points

Number	Signal	Value
TP1	ESTOP_5V	+5V normally, 0 ... +0.5V when emergency
switch		pressed down
TP2	ZDIR	0V driving up, +4.8V...+5V driving down
TP3	ZON	**Text wrong (+5V)**. Correct value +3V when up/down key pressed. Otherwise 0V.
TP4	+5V	+5V
TP5	GND	0V
TP6	ZACT*	0 ... +0.5 when up/down key pressed, otherwise close to +5V.

L100 - Test Switches

DANGER - HIGH VOLTAGE!
Take great care when pressing the switches SW1, SW2, SW3 not to touch indicator lamp LA1 which is 230 / 115VAC.

Switch	Operation
SW1	
	SW1 + SW2 Press simultaneously to drive vertical carriage up.
SW2	
	SW2 + SW3 Press simultaneously to drive vertical carriage down.
SW3	

L100 - Connectors

J100

Pin	Signal	Description
1	ZUP*	Z-movement drive up key pressed
2	ZDOWN*	Z-movement drive down key pressed
3	ZACTIN*	Z-movement key pressed
4	PLIN*	Position lights key pressed
5	RETIN*	Return key pressed
6	GND	GND (logic)

J101

Pin	Signal	Description
1	MSW*	Mirror switch
2	GND	GND (logic)

J102

Pin	Signal	Description
1	ZTOP	Z-movement reached top
2	GND	GND (logic)

J103

Pin	Signal	Description
1	ZBOTTOM	Z-movement reached bottom
2	GND	GND (logic)

J104

Pin	Signal	Description
1	AC1TR4OUT	AC motor power signals
3	AC1TR6OUT	AC motor power signals
6	AC2TR5OUT	AC motor power signals

J105

Pin	Signal	Description
1,2	AC1	230 or 115 VAC line voltage

J106

Pin	Signal	Description
1,2	AC2	230 or 115 VAC line voltage

J107

Pin	Signal	Description
1	ESTOP_5V	Emergency stop
2	POSLOUT3*	Position light 3

J108

Pin	Signal	Description
1	ESTOP_5V	Emergency stop
2	POSLOUT2*	Position light 2

J109

Pin	Signal	Description
1	ESTOP_5V	Emergency stop
2	POSLOUT1*	Position light 1

J110

Pin	Signal	Description
1	+5V	Supply voltage (logic)
2	ESTOP_5V	Emergency stop

J111

Pin	Signal	Description
1	EXPSW*	Exposure switch
2	READYLT	Ready light
3	EXPLT	Exposure light
4,6	GND	GND (logic)

J112

Pin	Signal	Description
1	TP0+	Ethernet, twisted pair 0
2	TP0-	Ethernet, twisted pair 0
3	TP1+	Ethernet, twisted pair 1
6	TP1-	Ethernet, twisted pair 1

J113

Pin	Signal	Description
1	TP0+	Ethernet, twisted pair 0
2	TP0-	Ethernet, twisted pair 0
3	TP1+	Ethernet, twisted pair 1
6	TP1-	Ethernet, twisted pair 1

J114

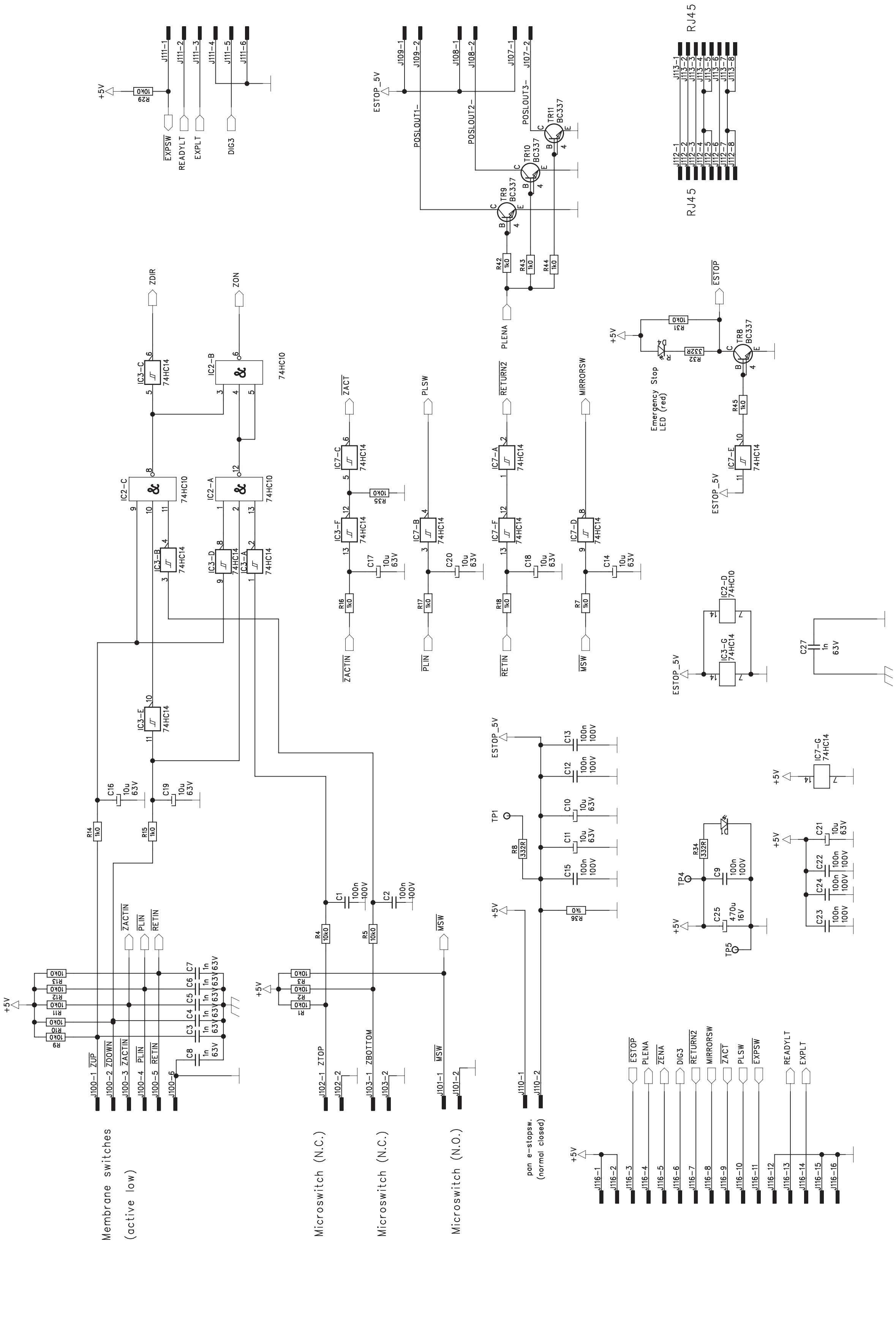
Pin	Signal	Description
1,2	AC1	230 or 115 VAC line voltage

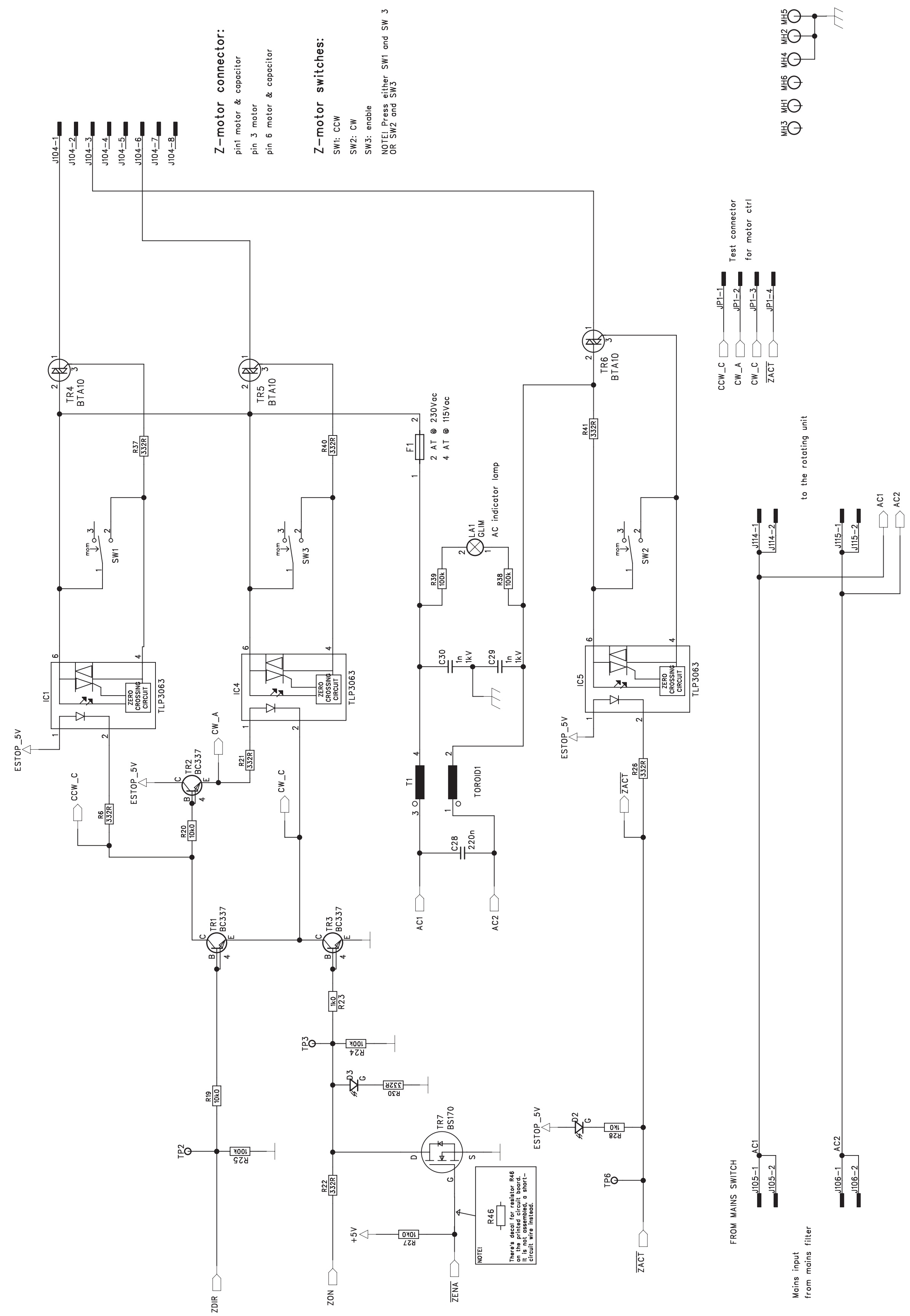
J115

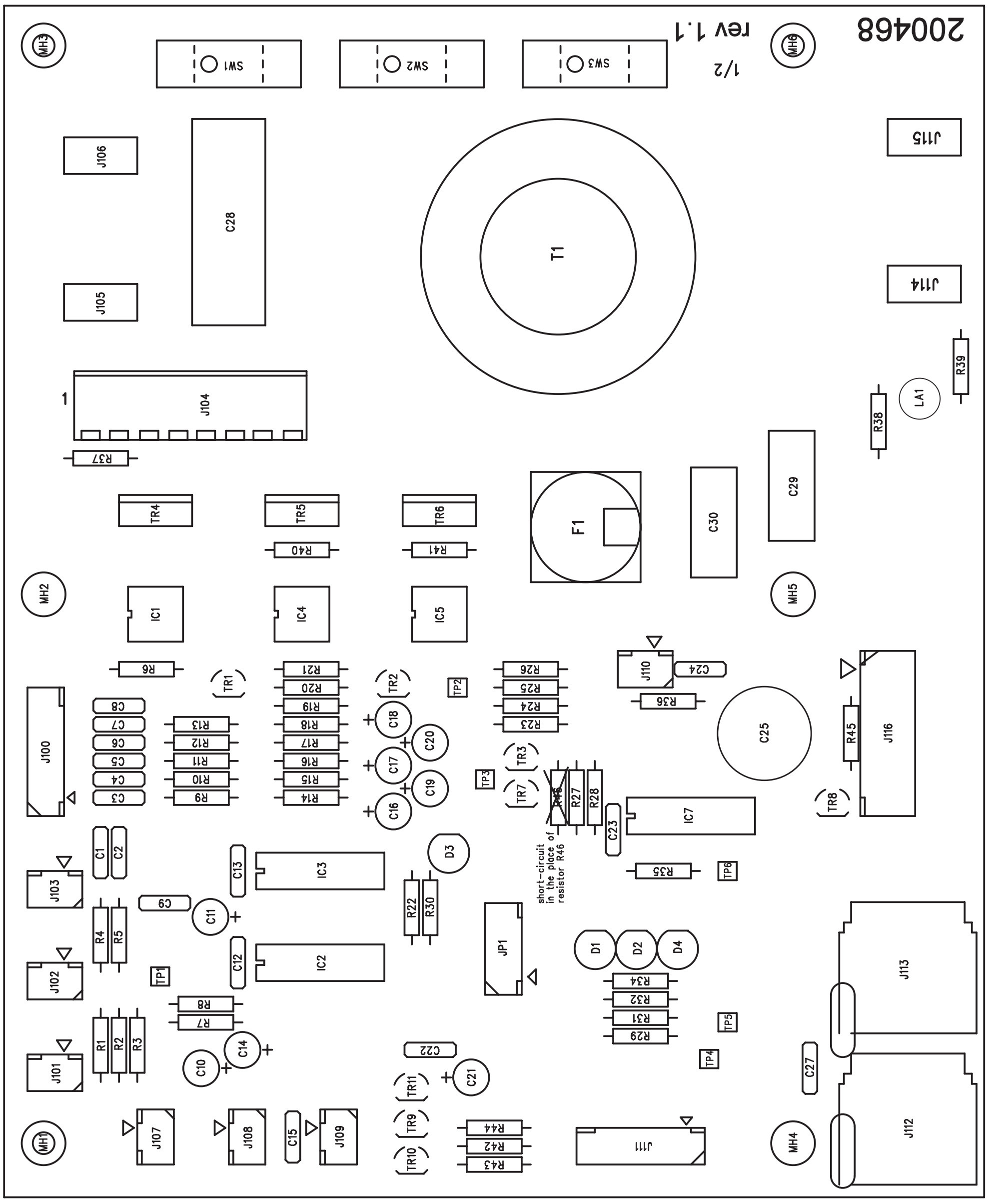
Pin	Signal	Description
1,2	AC2	230 or 115 VAC line voltage

J116

Pin	Signal	Description
1,2	+5V	Supply voltage (logic)
3	ESTOP*	Emergency stop on
4	PLENA	Position lights enable
5	ZENA*	Z-movement enable
7	RETURN2*	Rotating unit return
8	MIRRORSW	Mirror switch
9	ZACT*	Z-movement activity
10	PLSW	Position light switch
11	EXPSW*	Exposure switch
12,15,16	GND	GND (logic)
13	READYLT	Ready light on
14	EXPLT	Exposure light


Membrane switches
(active low)
Microswitch (N.C.)
Microswitch (N.C.)
Microswitch (N.O.)
pan e-stopsw.
(normal closed)
Emergency Stop
LED (red)
RJ45
RJ45

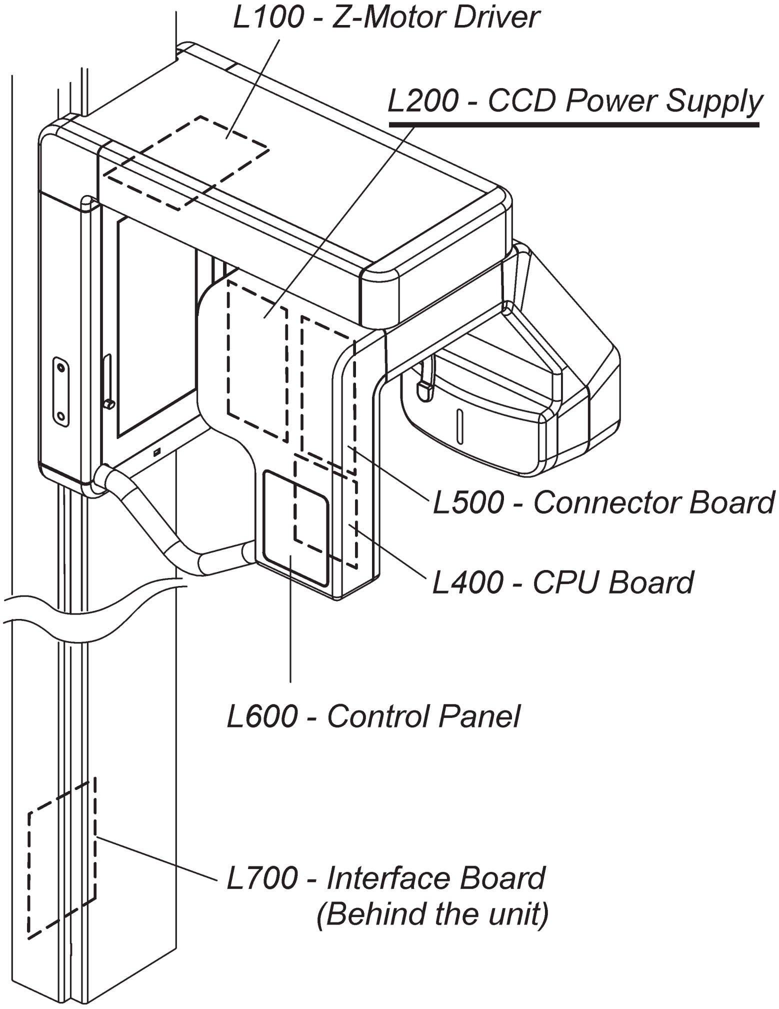

Z-motor connector:
pin1 motor & capacitor
pin 3 motor
pin 6 motor & capacitor
Z-motor switches:
SW1: CCW
SW2: CW
SW3: enable
NOTE! Press either SW1 and SW 3 OR SW2 and SW3
Test connector for motor ctrl
to the rotating unit
FROM MAINS SWITCH
Mains input from mains filter
AC indicator lamp
2 AT @ 230Vac
4 AT @ 115Vac
TLP3063
ZERO CROSSING CIRCUIT
BTA10
BC337
BS170
TOROID1
ESTOP_5V
CCW_C
CW_A
CW_C
ZACT
ZDIR
ZON
ZENA
AC1
AC2
NOTE! There's decal for resistor R46 on the printed circuit board. It is not assembled, a short-circuit wire instead.



3.2 L200, CCD Power Supply (Pt. no. 200396)

L200 - Location

In the rotating unit on the the CCD sensor side.
To access remove side cover left and the EMC shield (see section 7.1).



L200 - Field replaceable parts

Fuse 1, 2 and 3

NOTE:
The fuses used MUST be the approved type, UL listed and CSA certified.

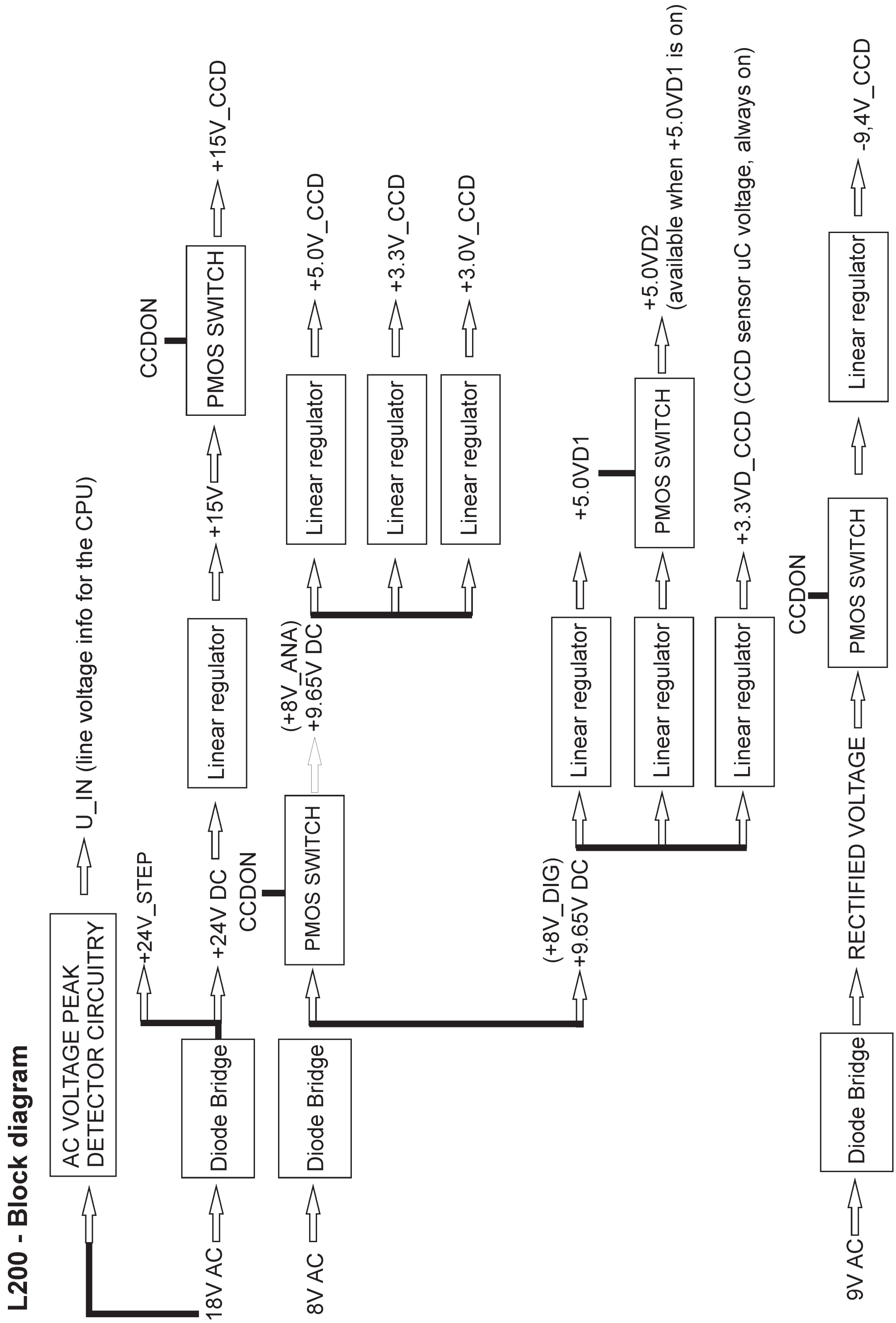
Fuse F1, 5AT/250VAC Cooper Bussmann S506-series
Fuse F2, 2AT/250VAC Cooper Bussmann S506-series
Fuse F3, 1AT/250VAC Cooper Bussmann S506-series

Dimensions, 5mm x 20mm.

L200 - Description

L200 supplies different voltages to most of the circuit boards in the unit. L200 receives three transformed AC voltages (18VAC, 9VAC, and 8VAC) from the Generator board, and rectifies and regulates them to produce the various voltages that the unit requires.
The CCD sensor require +3.3V, +3.3V, +3V, +15V, -9V, +5V.
The fan (it cools L200) and the 3-phase stepper motor require 24V.
L400 and pheripheral electronics require two regulated 5VDC power supplies.

L200 - Block diagram



L200 - Indicator LEDs

LED	Colour	Indicates
D1	green	+5.0VD1 on
D2	green	+5.0VD2 on
D3	green	+3.3VD_CCD on
D14	green	+15V on
D15	green	+3.0V_CCD on
D16	green	+5.0V_CCD on
D23	green	+3.3V_CCD on
D33	green	+15V_CCD on

L200 - Test Points

Number	Description	Value
TP1	GND (logic)	0V
TP2	+24V	+24V
TP5	+5.0VD1	
TP6	GND (logic)	0V
TP7	+3.0V_CCD	
TP8	+5.0V_CCD	
TP9	+3.3V_CCD	
TP10	+8V_RAW	
TP11	+5.0VD2	
TP12	+15V	
TP13	FAN VOLTAGE	>20V
TP14	+3.3V_CCD	
TP16	CCDENA	5V on, 0V off
TP17	-9.4V_CCD	
TP18	U_IN	Between 2.2V and 2.8V

L200 - Connectors

J201

Pin	Signal	Description
1	+5.0VD1	Supply voltage (L400 CPU)
2	GND	GND (logic)

J202

Pin	Signal	Description
1-4,15,16	GND	GND (logic)
5,6	+3.3V_CCD	Continuous supply voltage (CCD)
7,8	+15V_CCD	Supply voltage (CCD)
9,10	+3.0V_CCD	Supply voltage (CCD)
11,12	-9V_CCD	Supply voltage (CCD)
13,14	+5.0V_CCD	Supply voltage (CCD)

J204

Pin	Signal	Description
1	+5.0VD2	Supply voltage (logic)
2,4	GND	GND (logic)
3	+3.3V_CCD	Continuous supply voltage (CCD)
5	REGTEMP	Regulator temperature
6	CCDENA	CCD sensor supply voltage, +5V when active
7	U_IN	Line voltage peak level detection
8	FANPWM	Temperature controlled fan

J205

Pin	Signal	Description
1,4	18 VAC	Transformer secondary voltage
2,5	9 VAC	Transformer secondary voltage
3,6	8 VAC	Transformer secondary voltage

J206

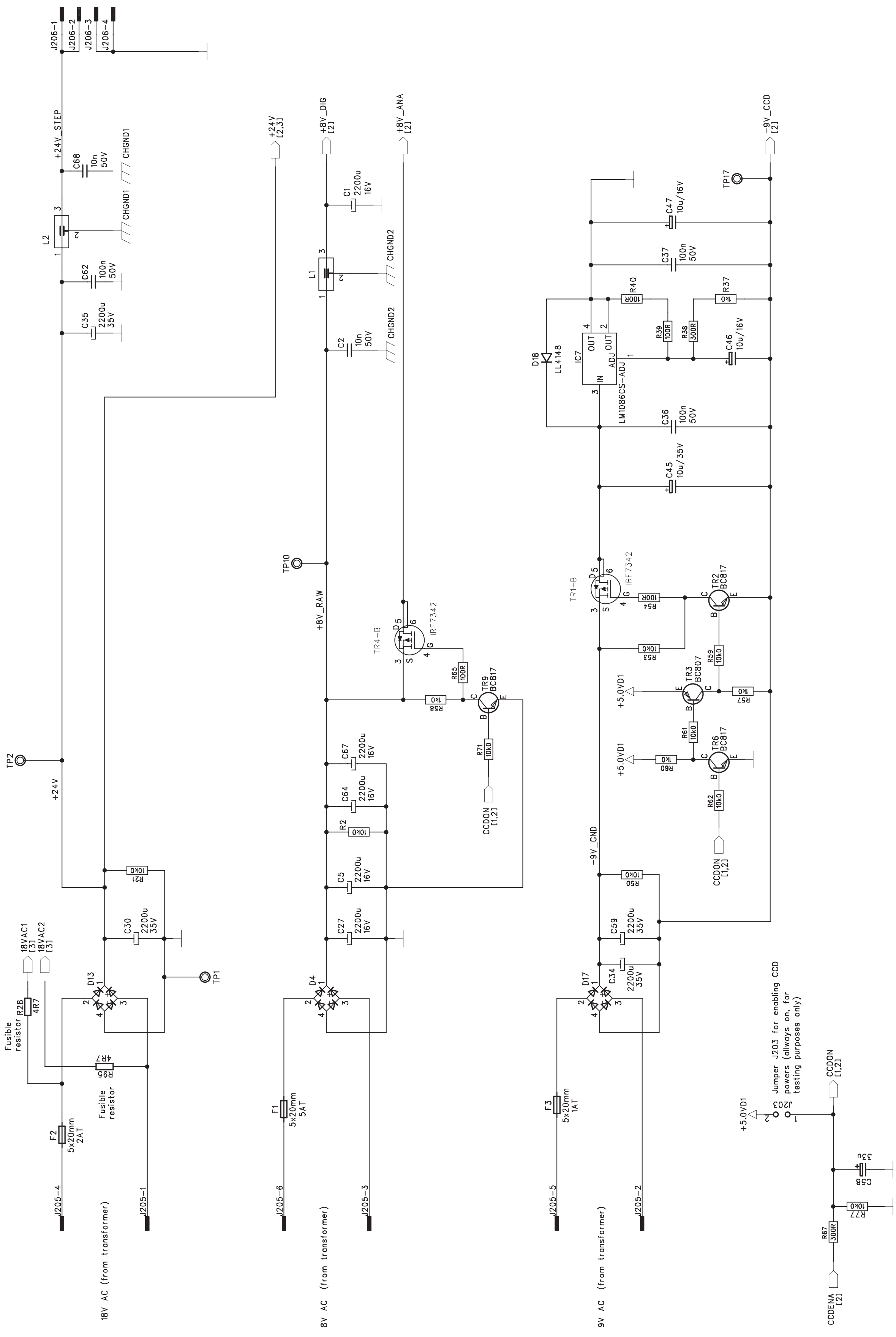
Pin	Signal	Description
1,2	+24V_STEP	Supply voltage (stepper motors)
3,4	GND	GND (logic)

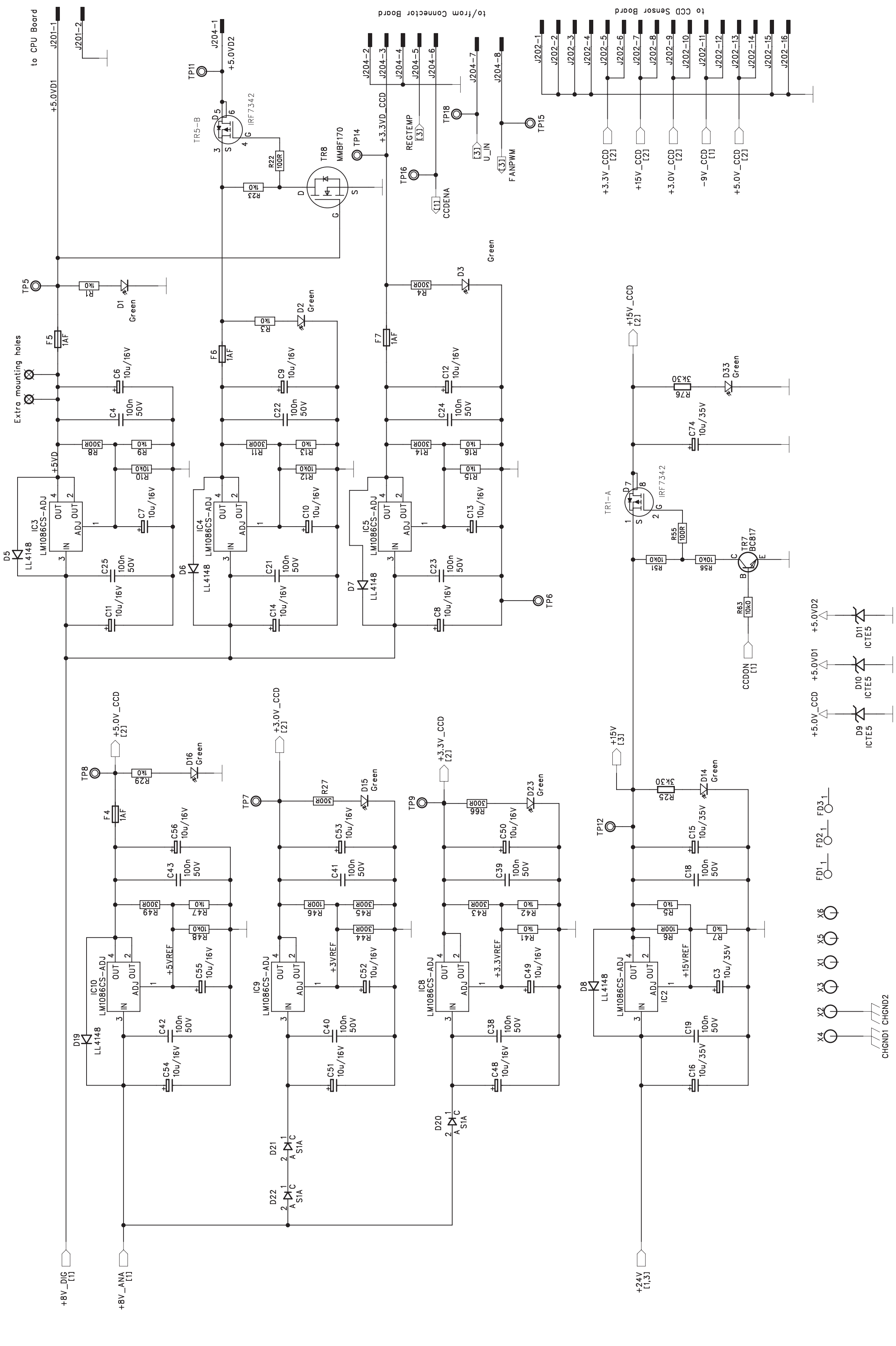
J207

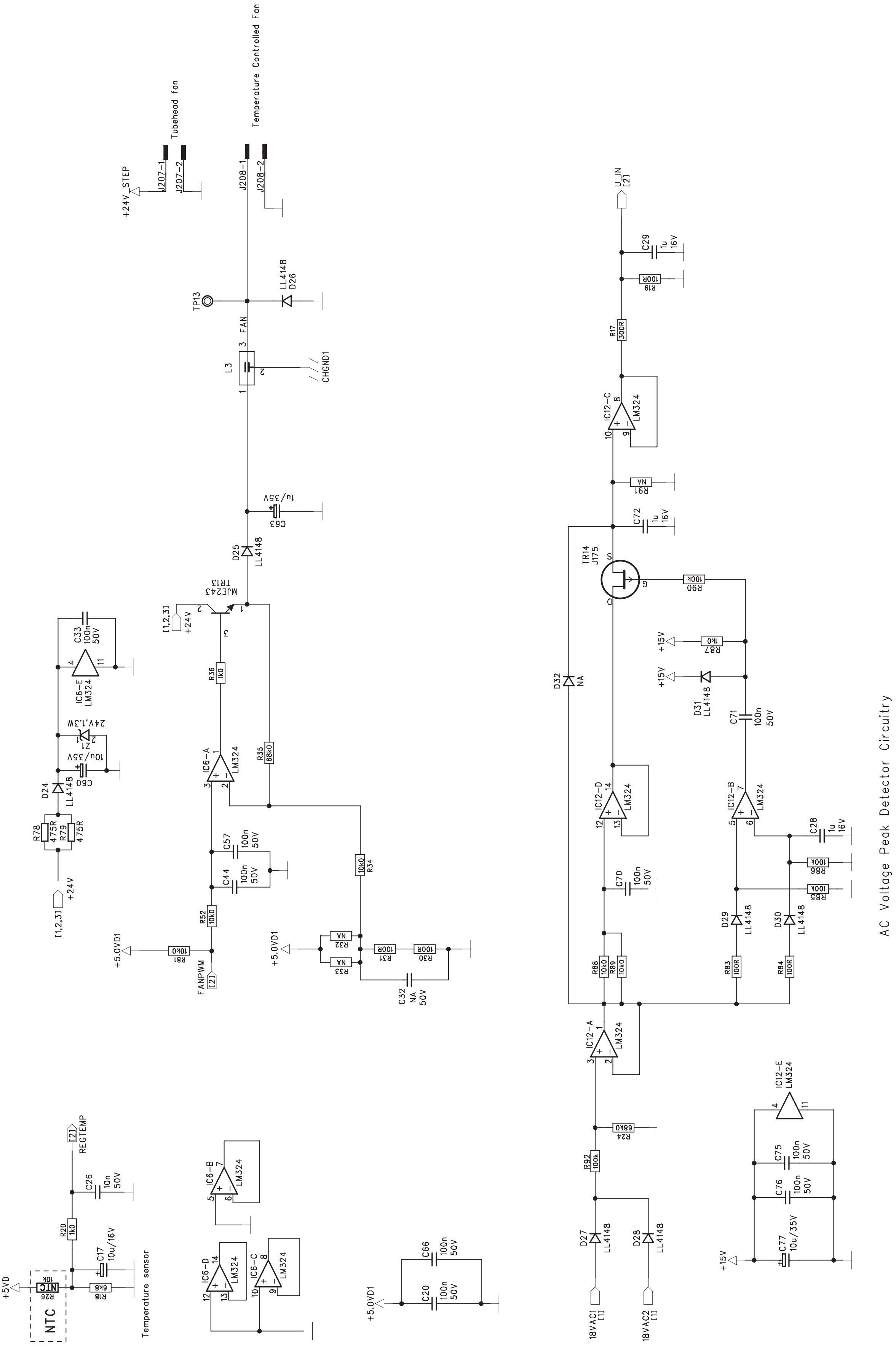
Not used

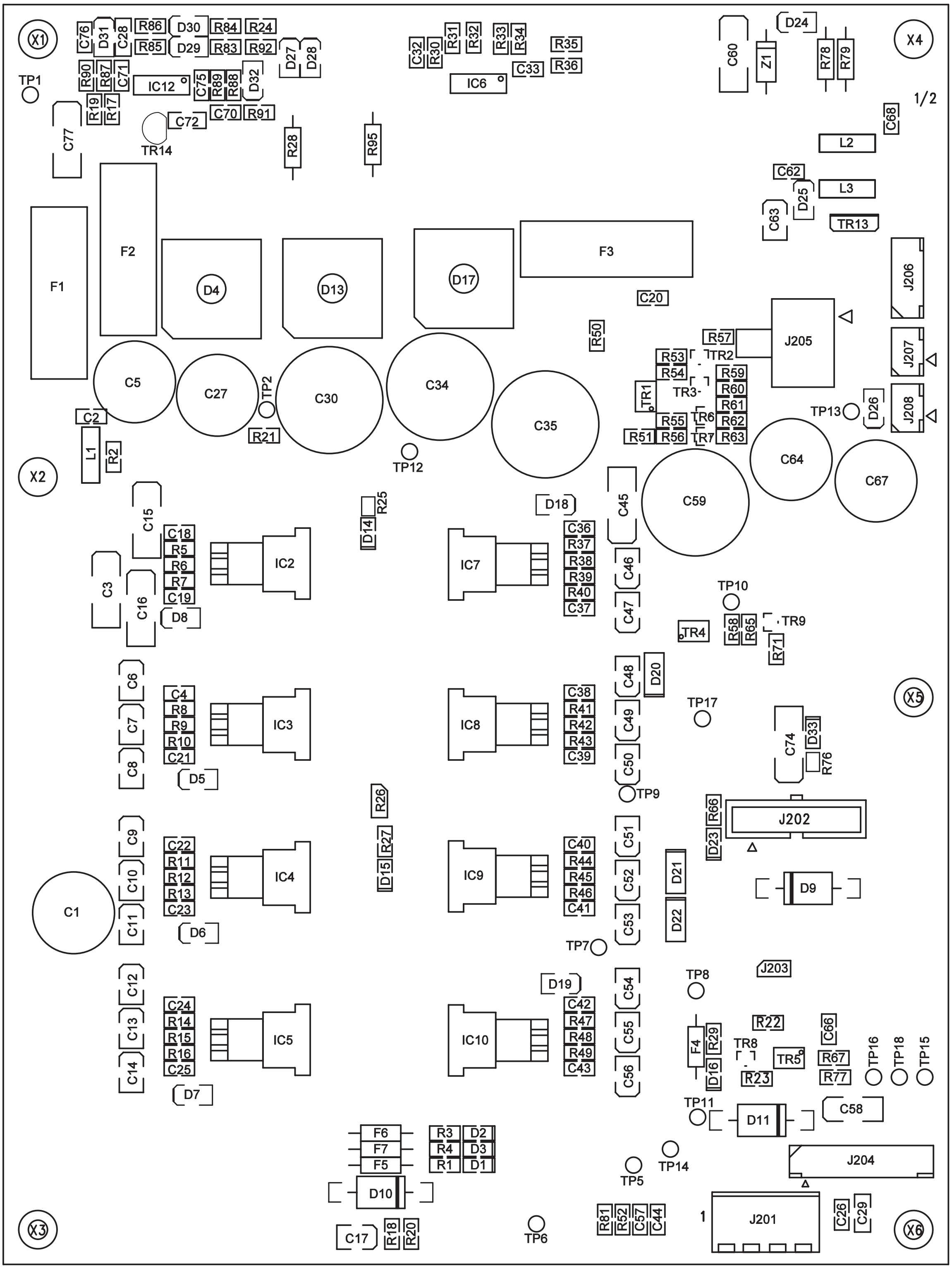
J208

Pin	Signal	Description
1	FAN	Supply voltage (temperature controlled fan)
2	GND	GND (logic)


J206-1
J206-2
J206-3
J206-4
+24V_STEP
C68 10n 50V
CHGND1
L2
C62 100n 50V
C35 2200u 35V
+24V [2,3]
+8V_DIG [2]
+8V_ANA [2]
C1 2200u 16V
L1
CHGND2
C2 10n 50V
TP10
+8V_RAW
TR4-B
IRF7342
R65 100R
TR9 BC817
R58 1k0
R71 10k0
CCDON [1,2]
C67 2200u 16V
C64 2200u 16V
R2 10k0
C5 2200u 16V
C27 2200u 16V
D4
F1 5x20mm 5AT
J205-6
J205-3
8V AC (from transformer)
TP2
+24V
R21 10k0
C30 2200u 35V
18VAC1 [3]
18VAC2 [3]
D13
TP1
Fusible resistor
R28 4R7
R95 4R7
F2 5x20mm 2AT
J205-4
J205-1
18V AC (from transformer)
-9V_CCD [2]
TP17
C47 10u/16V
C37 100n 50V
R40 100R
R37 1k0
R39 100R
R38 300R
C46 10u/16V
D18 LL4148
IC7
LM1086CS-ADJ
C36 100n 50V
C45 10u/35V
TR1-B
IRF7342
R54 100R
TR2 BC817
R53 10k0
R59 10k0
+5.0VD1
TR3 BC807
R57 1k0
R61 10k0
R60 1k0
TR6 BC817
R62 10k0
CCDON [1,2]
-9V_GND
R50 10k0
C59 2200u 35V
C34 2200u 35V
D17
F3 5x20mm 1AT
J205-5
J205-2
9V AC (from transformer)
J203
Jumper J203 for enabling CCD powers (allways on, for testing purposes only)
CCDON [1,2]
C58 33u
R77 10k0
R67 300R
CCDENA [2]


to CPU Board
to/from Connector Board
to CCD Sensor Board
Extra mounting holes

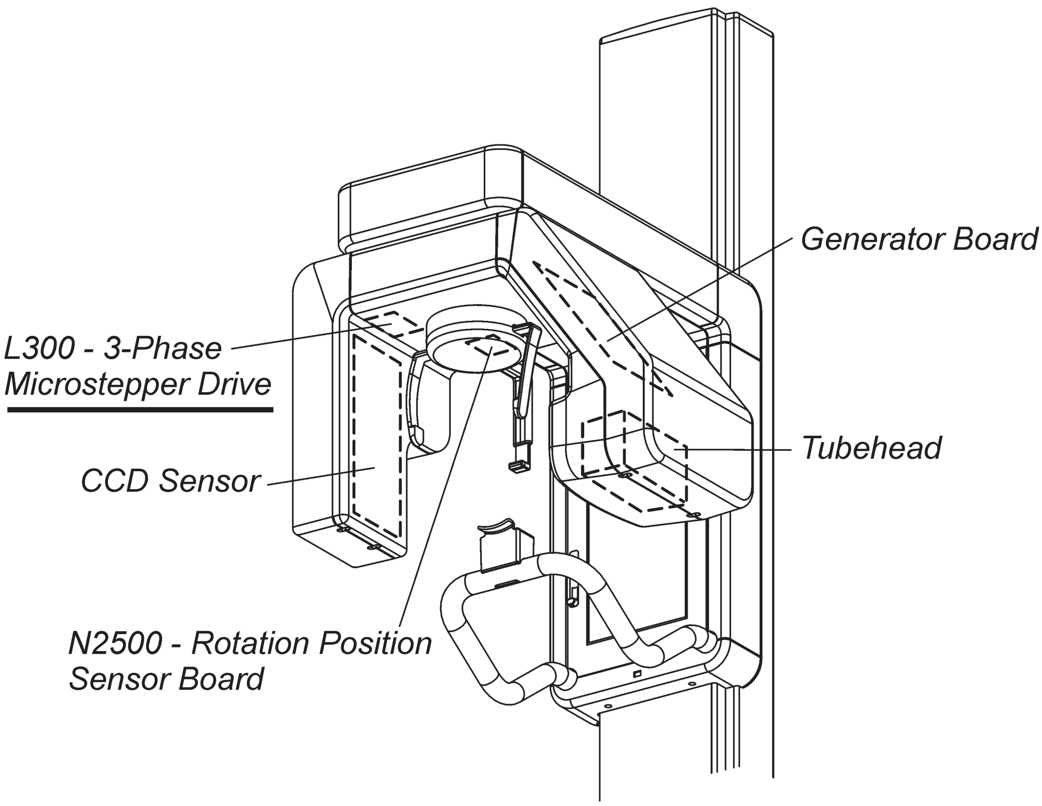

Tubehead fan
Temperature Controlled Fan
AC Voltage Peak Detector Circuitry
Temperature sensor
NTC
U_IN
FANPWM
REGTEMP


X1
C76
D31
C28
R86
D30
R84
R24
R85
D29
R83
R92
D27
D28
C32
R30
R31
R32
R33
R34
R35
R36
C33
IC6
C60
Z1
D24
R78
R79
X4
TP1
R90
R87
C71
IC12
C75
R89
R88
D32
R19
R17
C70
R91
C72
C77
TR14
R28
R95
1/2
C68
L2
C62
L3
D25
C63
TR13
F1
F2
D4
D13
D17
F3
C20
J206
R50
R57
J205
J207
R53
TR2
R54
R59
TR1
TR3
R60
R61
C5
C27
TP2
C30
C34
C35
R55
TR6
R62
TP13
D26
J208
C2
R21
R51
R56
TR7
R63
L1
R2
TP12
C64
C67
X2
C59
R25
D18
C45
C15
D14
C18
R5
R6
R7
C19
IC2
IC7
C36
R37
R38
R39
R40
C37
C46
C3
C16
D8
C47
TP10
TR4
R58
R65
TR9
R71
C6
C4
R8
R9
R10
C21
IC3
IC8
C38
R41
R42
R43
C39
C48
D20
TP17
X5
C7
C74
D33
R76
C8
D5
C49
C50
TP9
R26
R66
J202
D23
C9
C22
R11
R12
R13
C23
IC4
D15
R27
IC9
C40
R44
R45
R46
C41
C51
C52
D21
D9
C1
C10
C11
D6
C53
D22
TP7
J203
C12
D19
C54
TP8
C24
R14
R15
R16
C25
IC5
IC10
C42
R47
R48
R49
C43
C55
F4
R29
R22
C66
TR8
TR5
R67
TP16
TP18
TP15
C13
C14
D7
C56
D16
R23
R77
TP11
D11
C58
F6
F7
F5
R3
R4
R1
D2
D3
D1
J204
TP5
TP14
D10
1
J201
C26
C29
X3
C17
R18
R20
TP6
R81
R52
C57
C44
X6

3.3 L300, 3-Phase Microstepper Driver (Pt. no. 200397)

L300 - Location

Inside the rotating unit, above the head support. To access, remove the head support, lower protective cover and then the left aperture cover (see section 7.1).



L300 - Field replaceable parts

None.

L300 - Description

L300 controls the 3-phase stepper motor that drives the Rotating Unit. The board receives in three control signals: clock, dir, and ena. It produces phase voltages for the stepper motor windings.

L300 - Indicator LEDs

LED	Colour	Indicates
D1	green	+5V on
D2	green	+24V on

L300 - Test Points

Number	Description	Value
TP1	GND	0V
TP2	VREF	0.97V ±0.1V; when HICUR* = '1'
		1.95V ±0.1V; when HICUR* = '0' (default value)
TP3	CLK	+5V freq <15kHz
TP4	ENA	+5V active, 0V idle
TP5	DIR	+5V when idle or when moving to the PIO position.
		0V when driving to end position.
TP6	PGND	0V

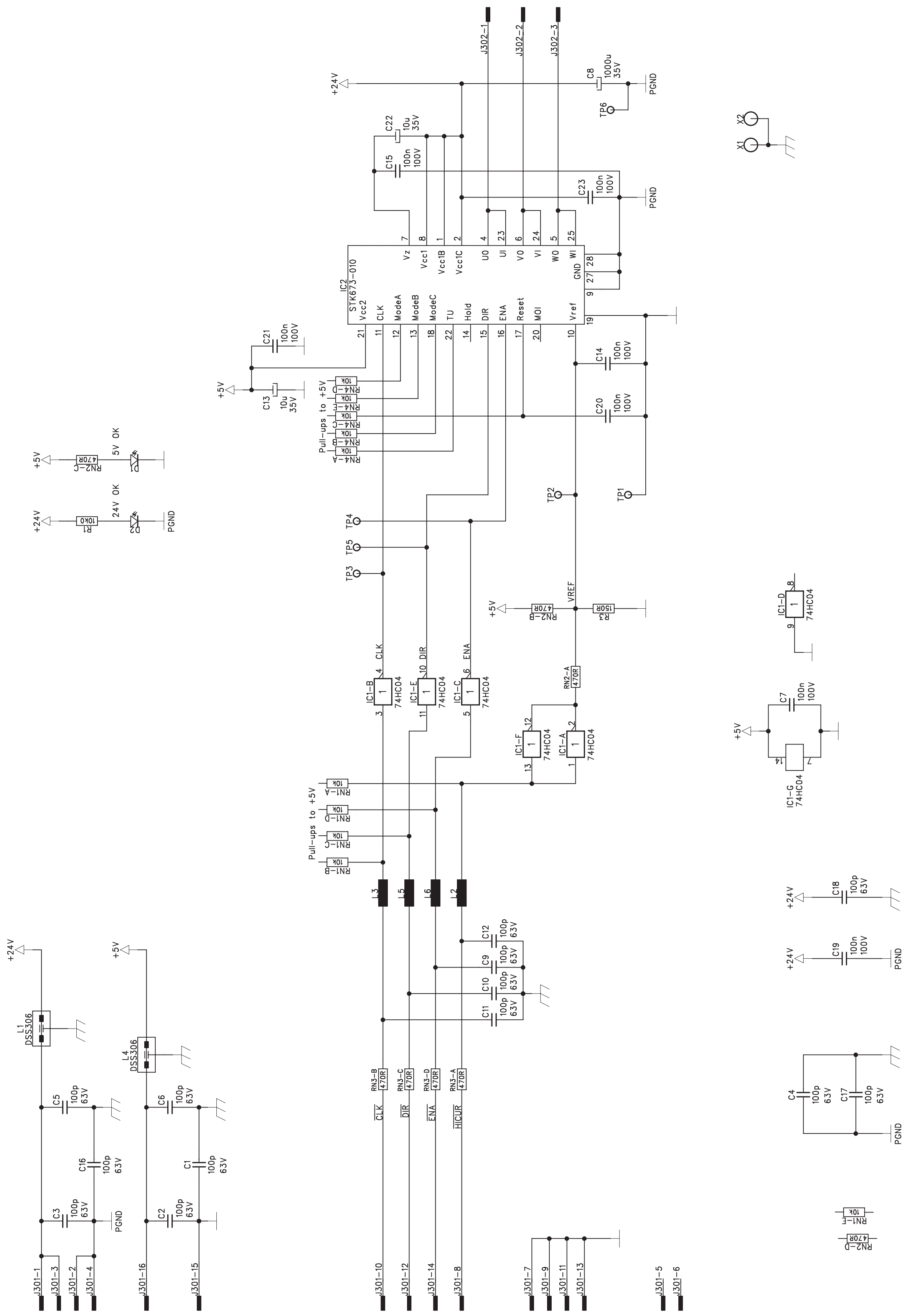
L300 - Connectors

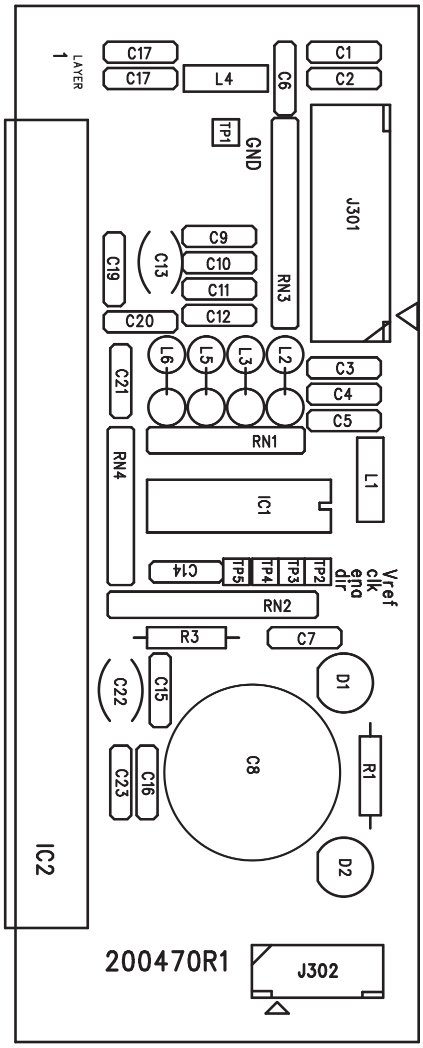
J301

Pin	Signal	Description
1,3	+24V	Power supply
2,4	PGND	Power GND
7,9,11,13,15	GND	GND (logic)
8	HICUR*	High current selection
10	CLK*	Stepper motor clock
12	DIR*	Stepper motor direction
14	ENA*	Stepper motor enabled
16	+5V	Power supply (logic)

J302

Pin	Signal	Description
1	Phase #1	Stepper motor driver's phase voltages
2	Phase #2	Stepper motor driver's phase voltages
3	Phase #3	Stepper motor driver's phase voltages

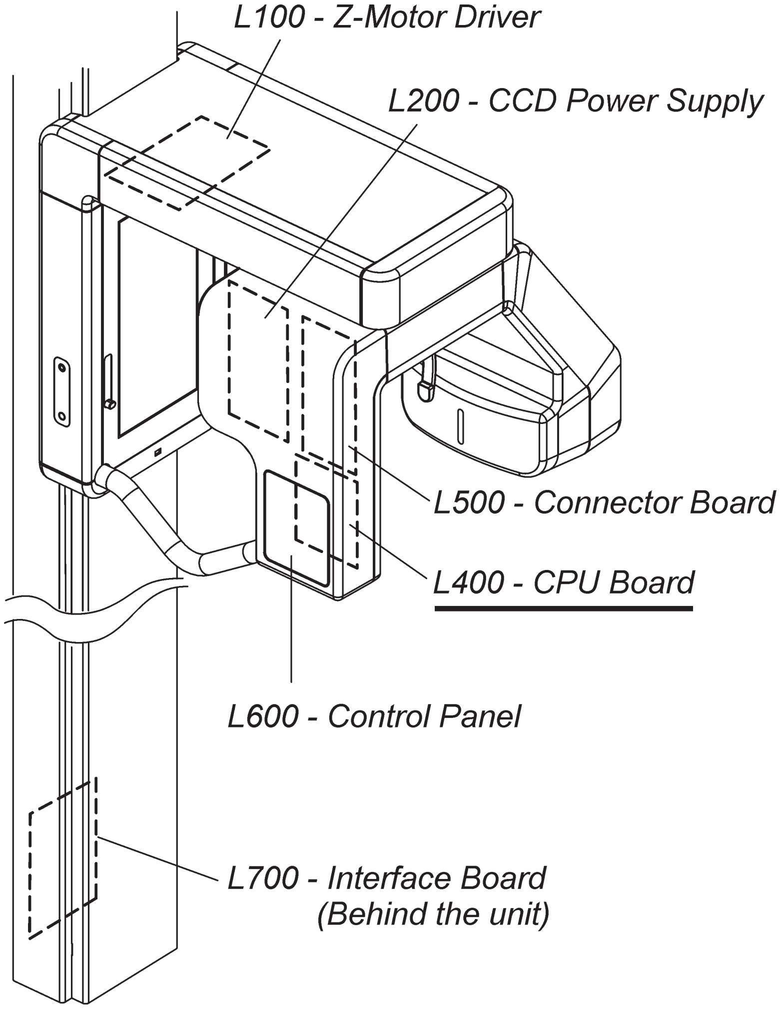

IC2
STK673-010
74HC04
DSS306
Pull-ups to +5V
5V OK
24V OK
VREF
CLK
DIR
ENA
HICUR
PGND
+24V
+5V


1 LAYER
C17
C17
L4
C6
C1
C2
TP1
GND
J301
RN3
C19
C13
C9
C10
C11
C12
C20
L6
L5
L3
L2
C3
C4
C5
C21
RN1
RN4
L1
IC1
C14
TP5
TP4
TP3
TP2
Vref
clk
ena
dir
RN2
R3
C7
D1
C22
C15
C8
R1
C23
C16
IC2
D2
200470R1
J302

3.4 L400 CPU Board (Pt. no. 200398)

L400 - Location

In rotating unit on the the CCD sensor side. To access remove side cover left and the EMC shield (see section 7.1).



L400 - Field replaceable parts

None.

L400 - Description

The CPU board controls the unit. It controls the rotation and Z movements, the operation of the X-ray tube and reads the signals from the control panel. It uses an embedded microcontroller on an Altera Cyclone FPGA circuit. The board also has an Ethernet transceiver (for PC connection), I/O buffers, and a 14-bit A/D converter. The image bits are saved in an SDRAM.

L400 - Indicator LEDs

LED	Colour	Indicates
D1	green	100-Base-T (100MBit/s) in use
D2	green	Ethernet signal activity
D3	green	Full Duplex mode in use
D4	green	10-Base-T (10Mbit/s) in use
D6	green	+5V on

L400 - Connectors

J203_CPU

Pin	Signal	Description
1	+5V_CPU	Power supply CPU
2,4,6	GND	GND (logic)
3	VV	Valid video
5	DS	Data strobe
7	D0	Data bit 0
8	D1	Data bit 1
9	D2	Data bit 2
10	D3	Data bit 3
11	D4	Data bit 4
12	D5	Data bit 5
13	REGTEMP	Temperature of the regulators on L200 board.
14,16,18,20	GND	GND (logic)
15	MOSI	SPI signal
17	SCLK	SPI clock
19	CS*	Chip select
21	BEEP	Beeper enable
22	mA_ref	Current reference
23	kV_ref	Voltage reference
24	PREH*	Preheat
25	EXPON	Exposure on (CPU enabled)
26,34,36,38	GND	GND (logic)
27	IMAGE	Enables A/D conversion on CCD Sensor Board
28	A/D_2	NOT USED
29	TDI CLK	Time Delay Integration Clock (CCD)
30	TXD	Transmit data (serial connection)

31	CCDENA	Enables the supply voltages for the CCD sensor
32	PPOWER	CCD sensor's supply voltages are on
33	CLK	Stepper motor clock
35	DIR	Stepper motor direction
37	ENA	Stepper motor enabled
39	+5V_CPU	CPU Power supply CPU
40	GND	GND (logic)

J204_CPU

Pin	Signal	Description
1	TP0+	Ethernet, twisted pair 0
2	TP0-	Ethernet, twisted pair 0
3	TP1+	Ethernet, twisted pair 1
4	TP1-	Ethernet, twisted pair 1

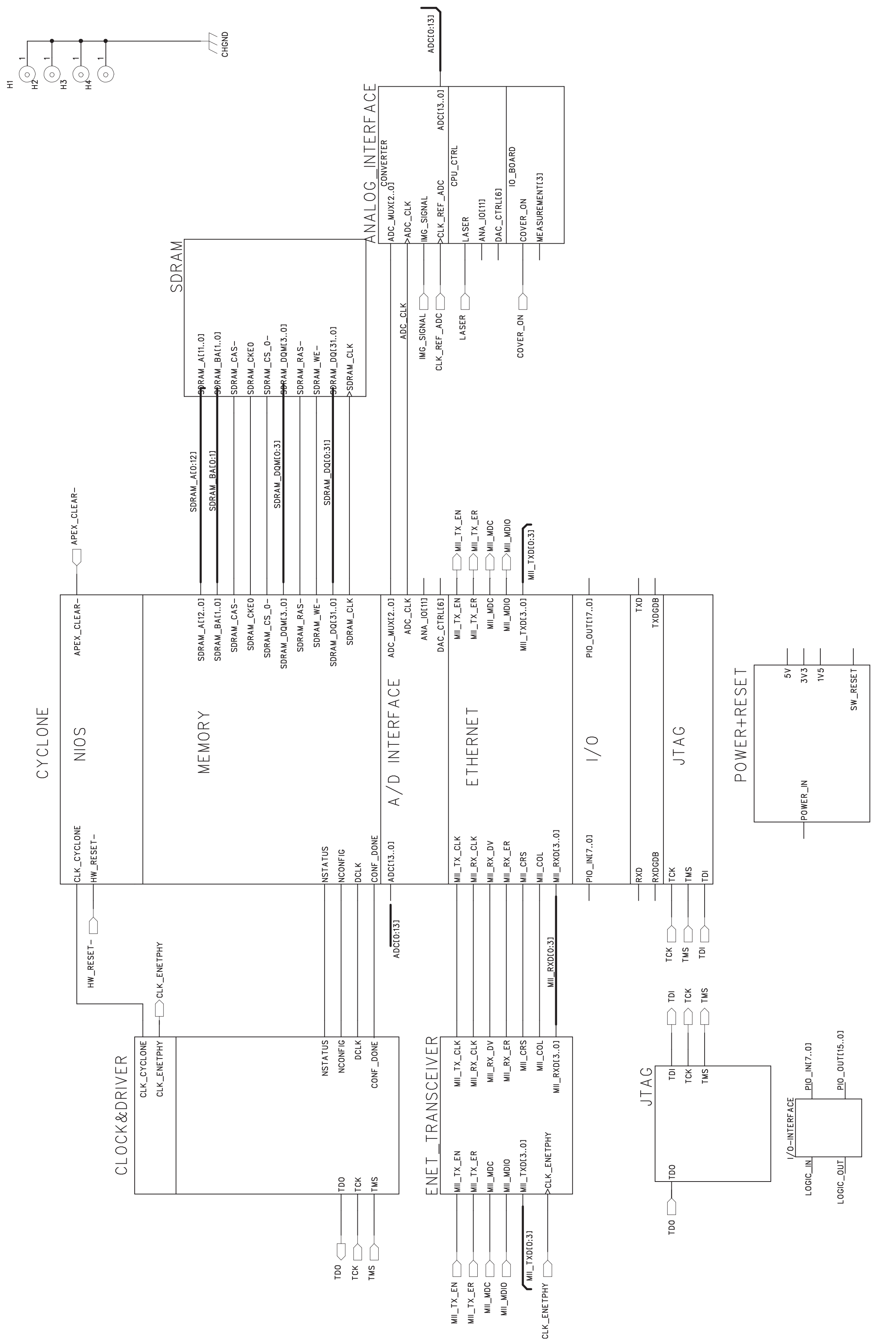
J205_CPU

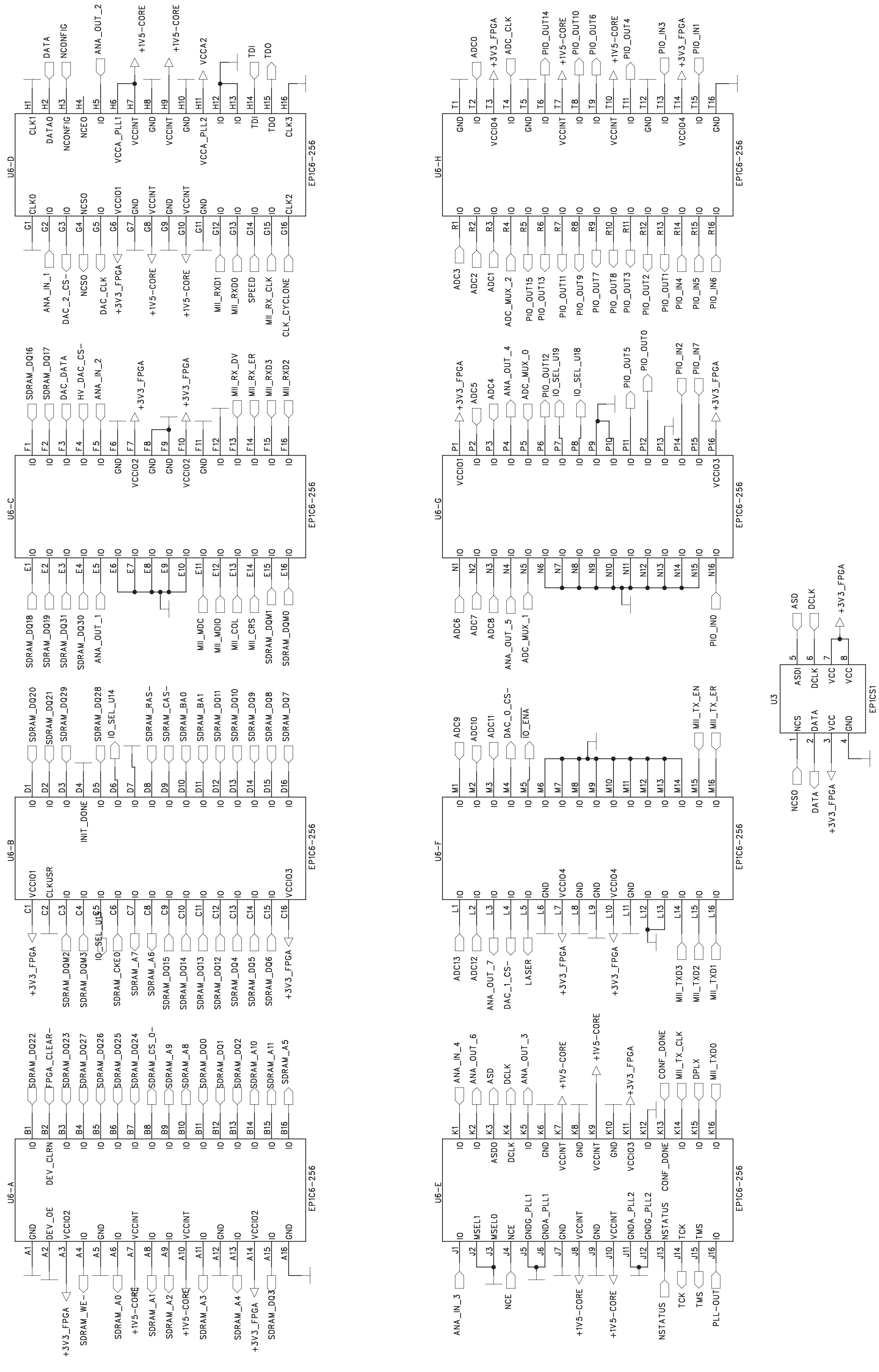
Pin	Signal	Description
1	+5V	Power supply (logic)
2	GND	GND (l ogic)

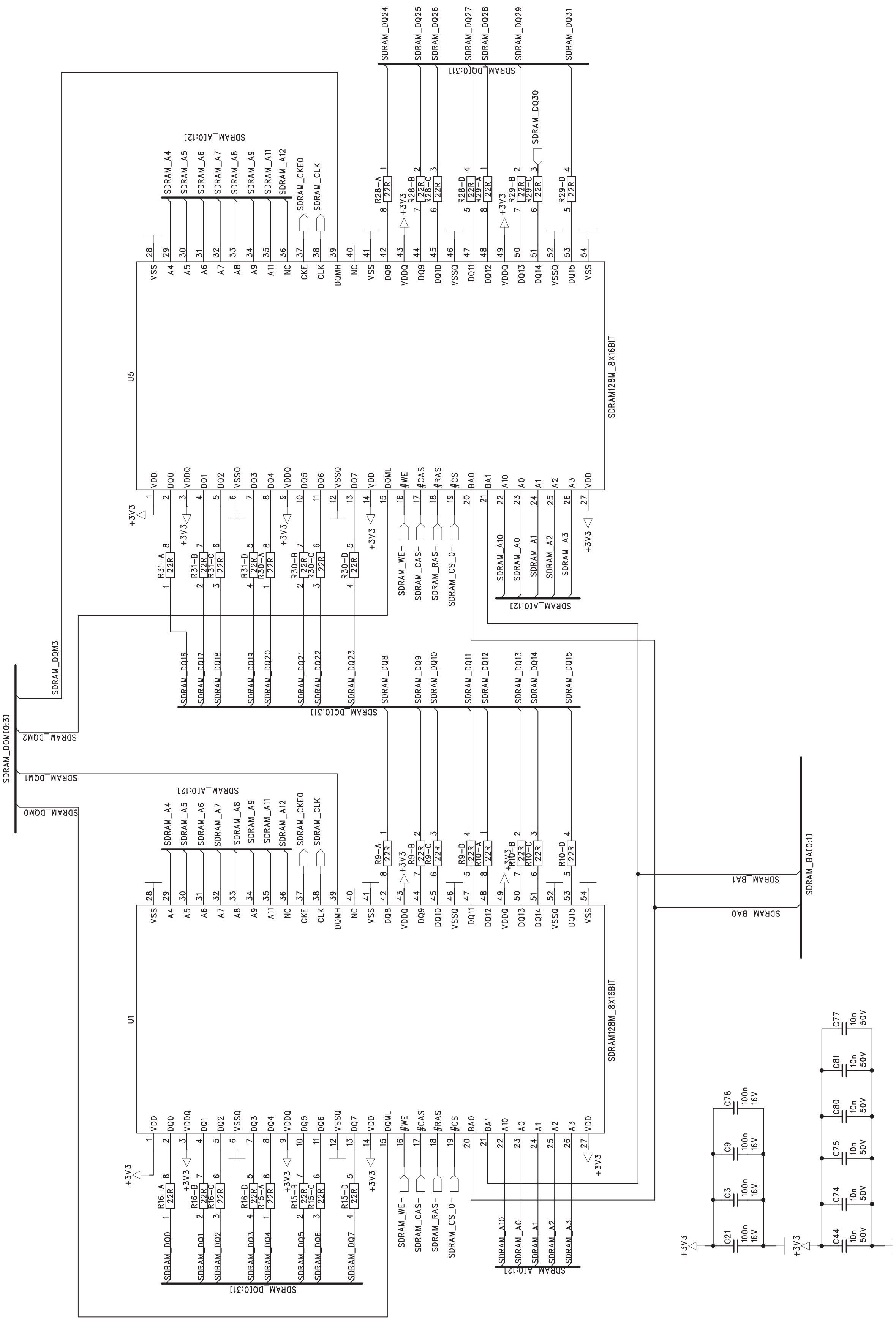
J3_CPU

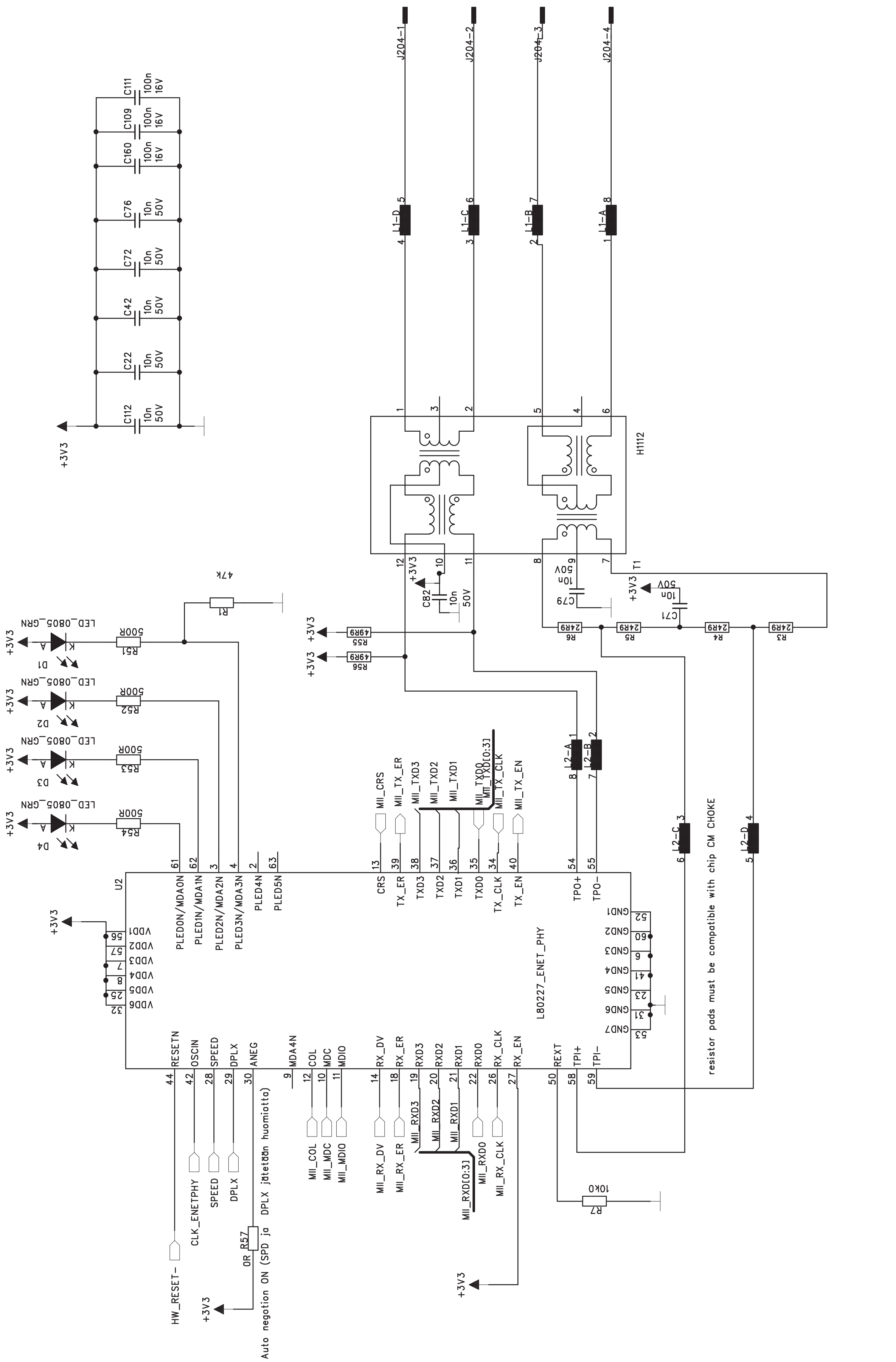
Pin	Signal	Description
1	-	NOT USED
2	TUBEHEAT	The X-ray tube's temperature (analog signal)
3	-	NOT USED
4	A/D_1	NOT USED
5	-	NOT USED
6	LINEOK	Line voltage
7	-	NOT USED
8	mAfb	mA feedback
9	-	NOT USED
10	kVfb	kV feedback
11	-	NOT USED
12-19	GNDA	A/D converter's ground
20-24	+5VA	A/D converter's supply voltage
25	-	NOT USED
26	ZENA*	Z-motor movement enabled
27	RESET_CCD*	Resets CCD sensor
28	PL_ENA	Position lights enabled
29	HICUR*	High current selection
30	FAN_PWM	Temperature controlled fan

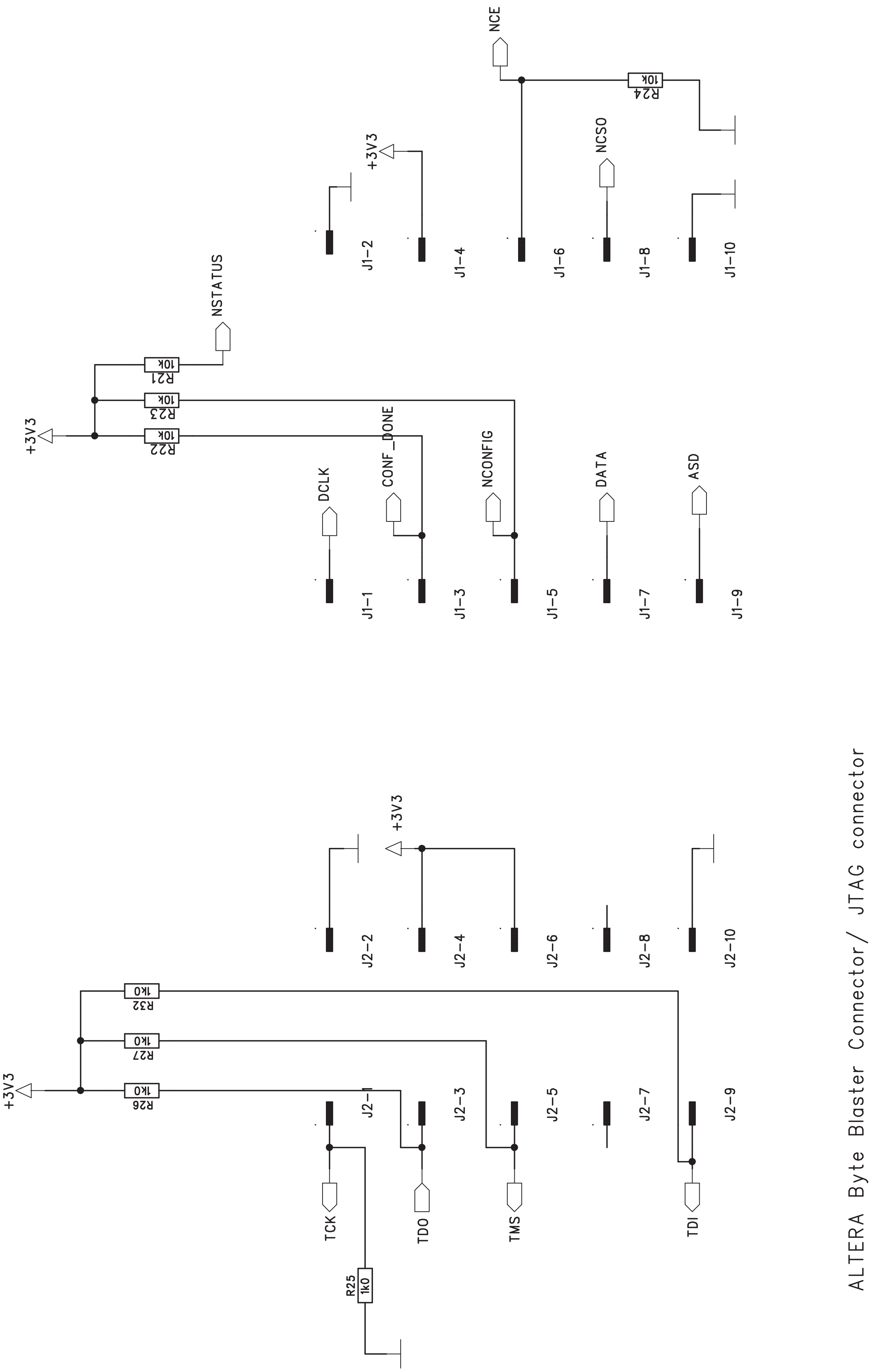
31	OUT1	NOT USED
32	OUT2	NOT USED
33	OUT3	NOT USED
34	ROTSW1	Rotation position switch signal
35	ROTSW2	Rotation position switch signal
36	RXD	Receive data (serial connection) from CCD
37	MISO	SPI signal
38	-	NOT USED
39	-	NOT USED
40	-	NOT USED
41	ZACT*	Up/down key on side control panel pressed
42	MIRRORSW	Mirror switch
43	TUBEFAIL*	X-ray tube failure
44	-	NOT USED
45	-	NOT USED
46	PLSW	Position light switch
47	HL	High/low bit
48	EXPSW*	Exposure switch
49	+3V3	Power supply
50	GND	GND (logic)

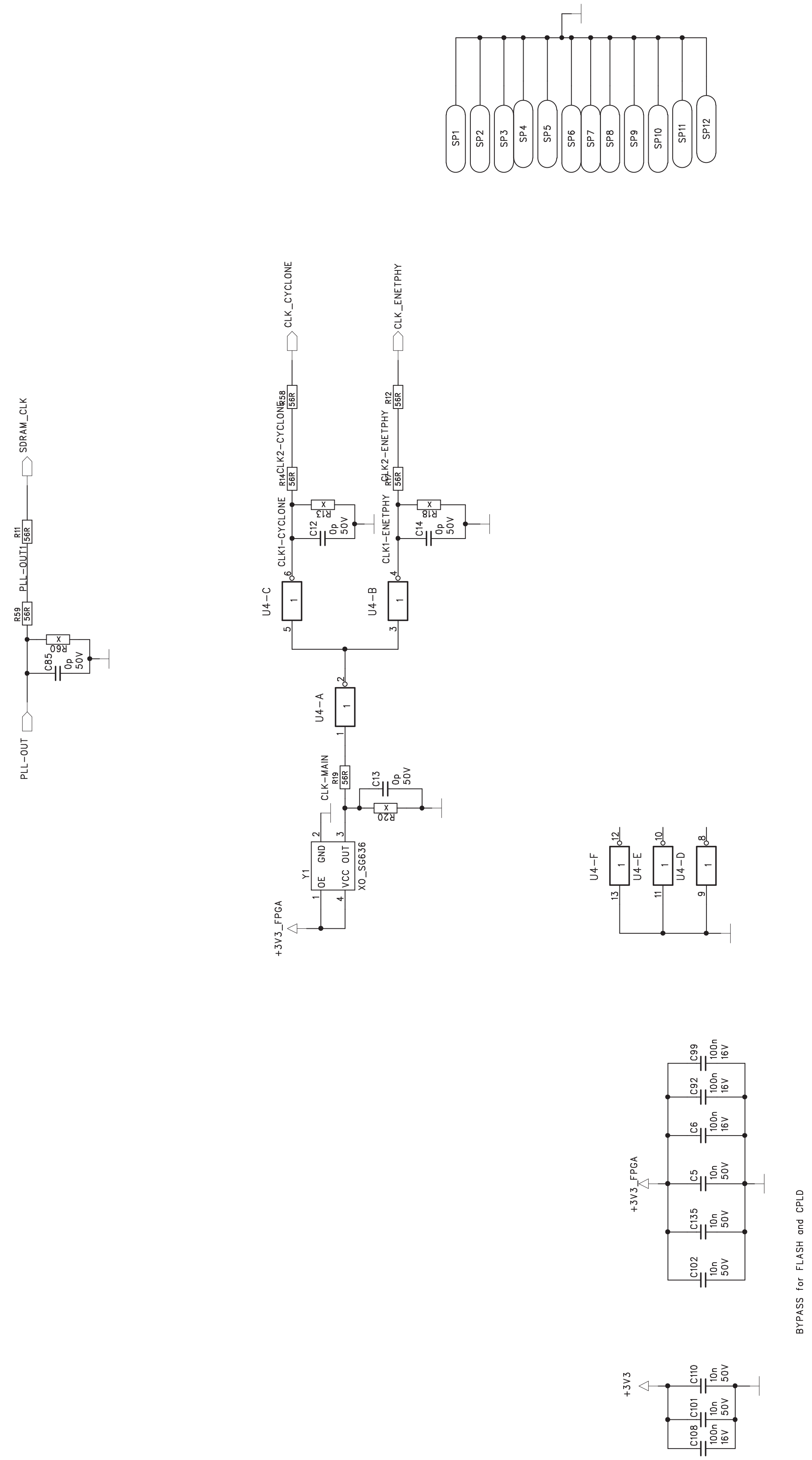

H1
H2
H3
H4
CHGND
ADC[0:13]
ANALOG_INTERFACE
CONVERTER
ADC_MUX[2..0]
ADC_CLK
IMG_SIGNAL
CLK_REF_ADC
ADC[13..0]
CPU_CTRL
LASER
ANA_IO[11]
DAC_CTRL[6]
IO_BOARD
COVER_ON
MEASUREMENT[3]
SDRAM
SDRAM_A[11..0]
SDRAM_BA[1..0]
SDRAM_CAS-
SDRAM_CKE0
SDRAM_CS_0-
SDRAM_DQM[3..0]
SDRAM_RAS-
SDRAM_WE-
SDRAM_DQ[31..0]
SDRAM_CLK
SDRAM_A[0:12]
SDRAM_BA[0:1]
SDRAM_DQM[0:3]
SDRAM_DQ[0:31]
APEX_CLEAR-
MII_TX_EN
MII_TX_ER
MII_MDC
MII_MDIO
MII_TXD[0:3]
CYCLONE
NIOS
MEMORY
A/D INTERFACE
ETHERNET
I/O
JTAG
SDRAM_A[12..0]
ANA_IO[11]
MII_TXD[3..0]
PIO_OUT[7..0]
TXD
TXDGDB
CLK_CYCLONE
HW_RESET-
NSTATUS
NCONFIG
DCLK
CONF_DONE
ADC[13..0]
MII_TX_CLK
MII_RX_CLK
MII_RX_DV
MII_RX_ER
MII_CRS
MII_COL
MII_RXD[3..0]
PIO_IN[7..0]
RXD
RXDGDB
TCK
TMS
TDI
POWER+RESET
5V
3V3
1V5
SW_RESET
POWER_IN
CLK_ENETPHY
MII_RXD[0:3]
CLOCK&DRIVER
TDO
ENET_TRANSCEIVER
I/O-INTERFACE
PIO_OUT[15..0]
LOGIC_IN
LOGIC_OUT

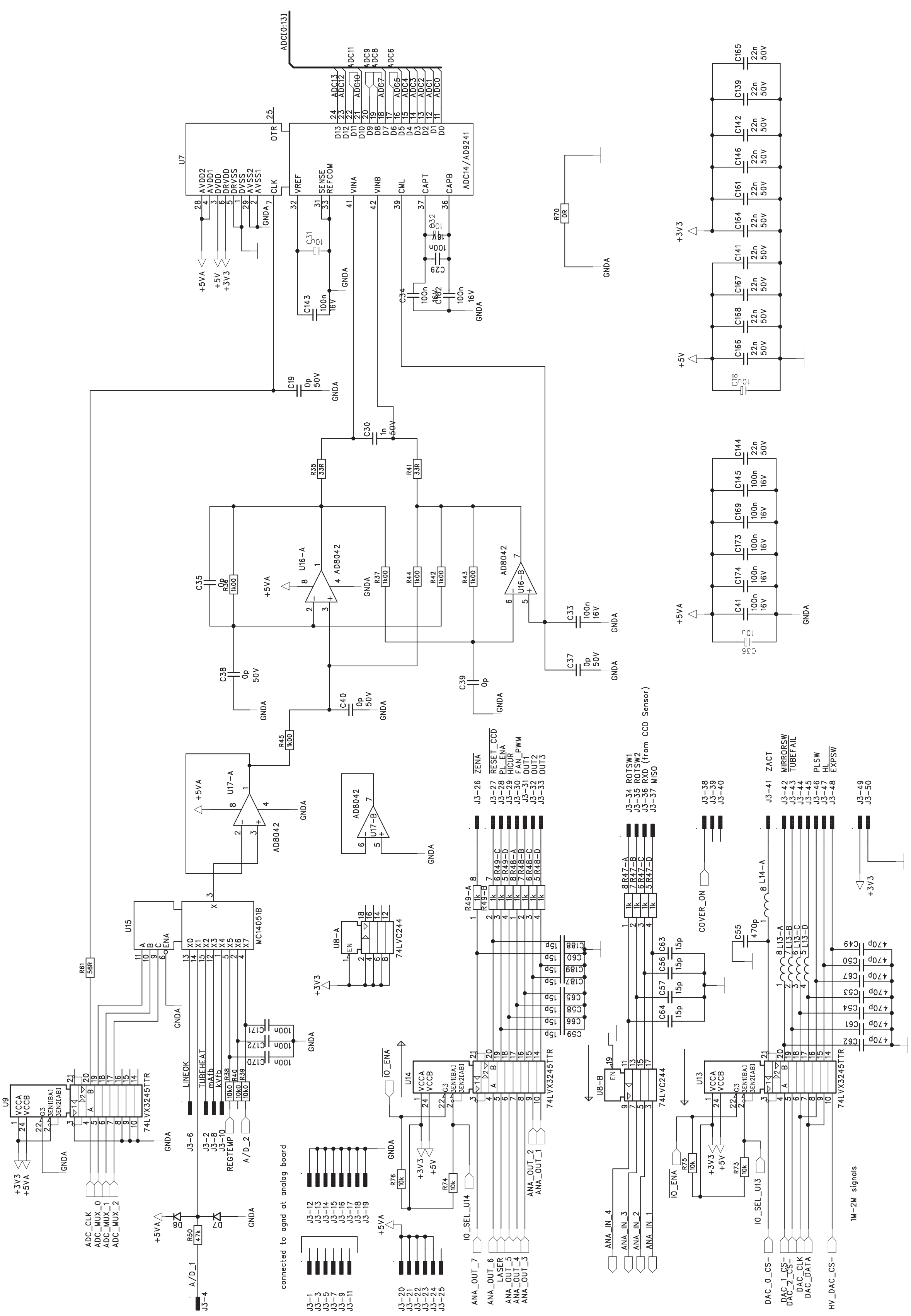

U6-A
U6-B
U6-C
U6-D
U6-E
U6-F
U6-G
U6-H
EP1C6-256
U3
EP1CS1

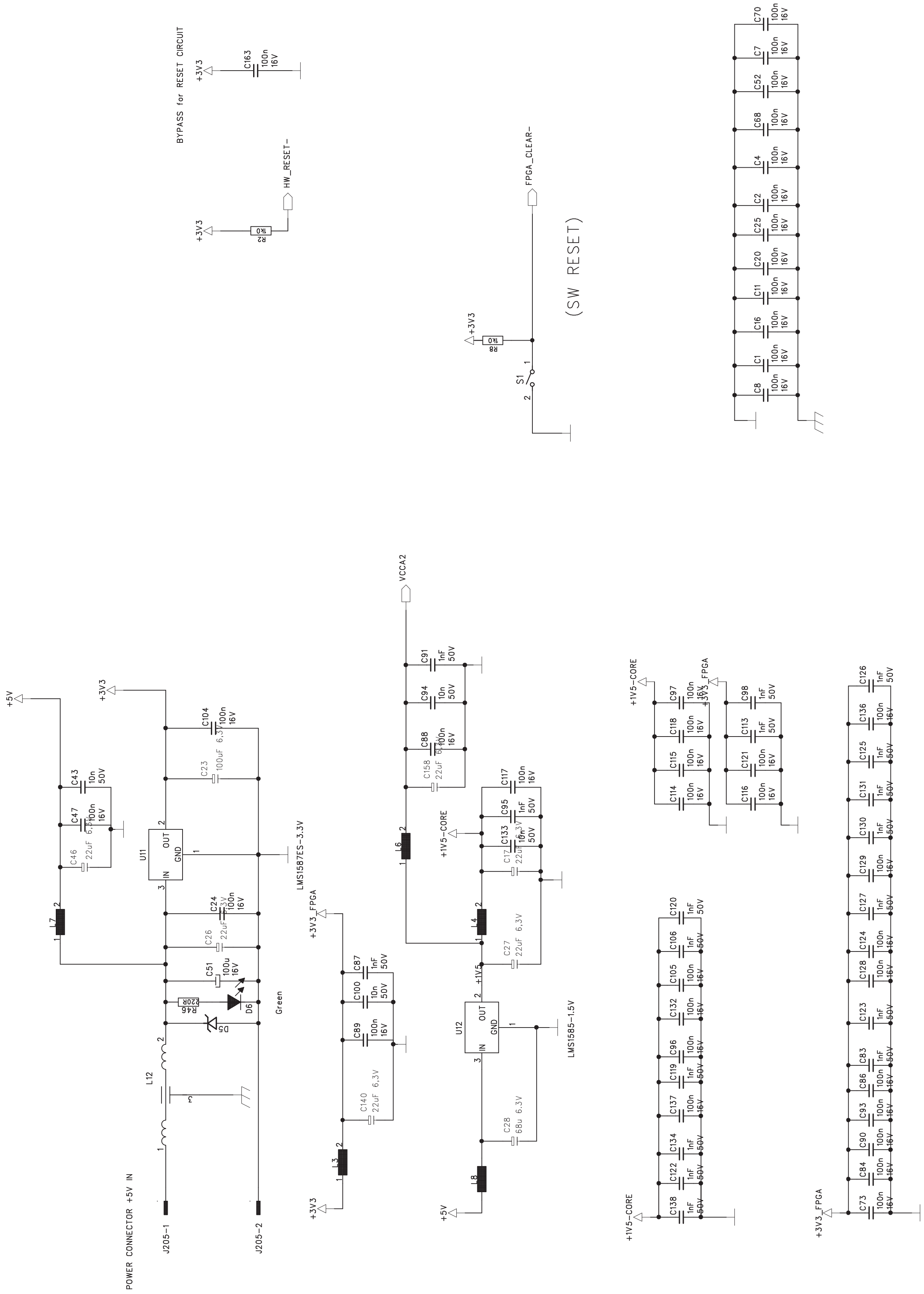

U5
SDRAM128M_8X16BIT
U1
SDRAM128M_8X16BIT
SDRAM_DQ[0:31]
SDRAM_A[0:12]
SDRAM_DQM[0:3]
SDRAM_DQM0
SDRAM_DQM1
SDRAM_DQM2
SDRAM_DQM3
SDRAM_BA[0:1]
SDRAM_BA0
SDRAM_BA1
SDRAM_CKE0
SDRAM_CLK
SDRAM_WE-
SDRAM_CAS-
SDRAM_RAS-
SDRAM_CS_0-
+3V3
22R
C21 100n 16V
C3 100n 16V
C9 100n 16V
C78 100n 16V
C44 10n 50V
C74 10n 50V
C75 10n 50V
C80 10n 50V
C81 10n 50V
C77 10n 50V

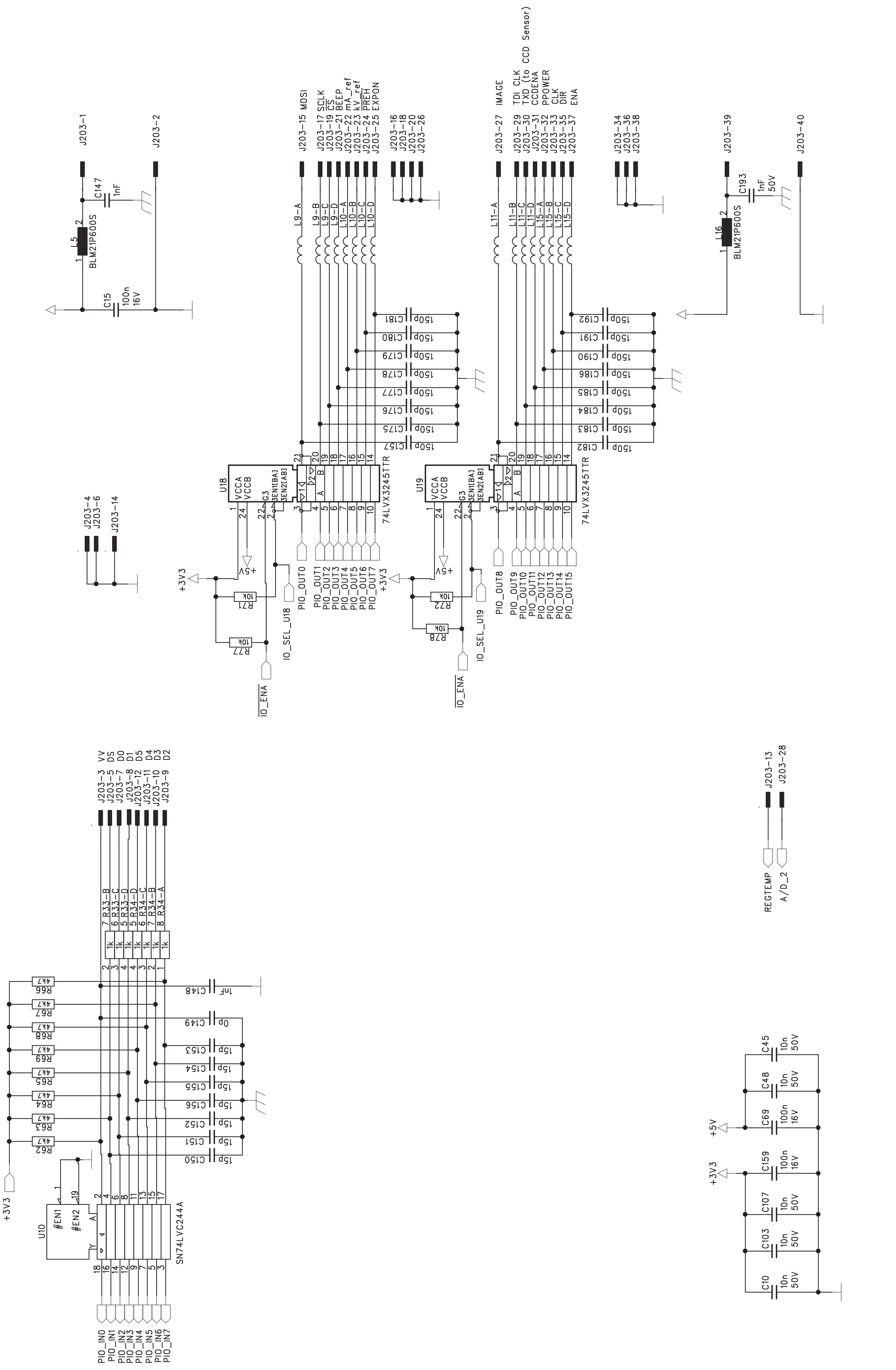

J204-1
J204-2
J204-3
J204-4
H1112
T1
U2
L80227_ENET_PHY
resistor pads must be compatible with chip CM CHOKE
Auto negotion ON (SPD ja DPLX jätetään huomiotta)
HW_RESET-
CLK_ENETPHY
SPEED
DPLX
+3V3

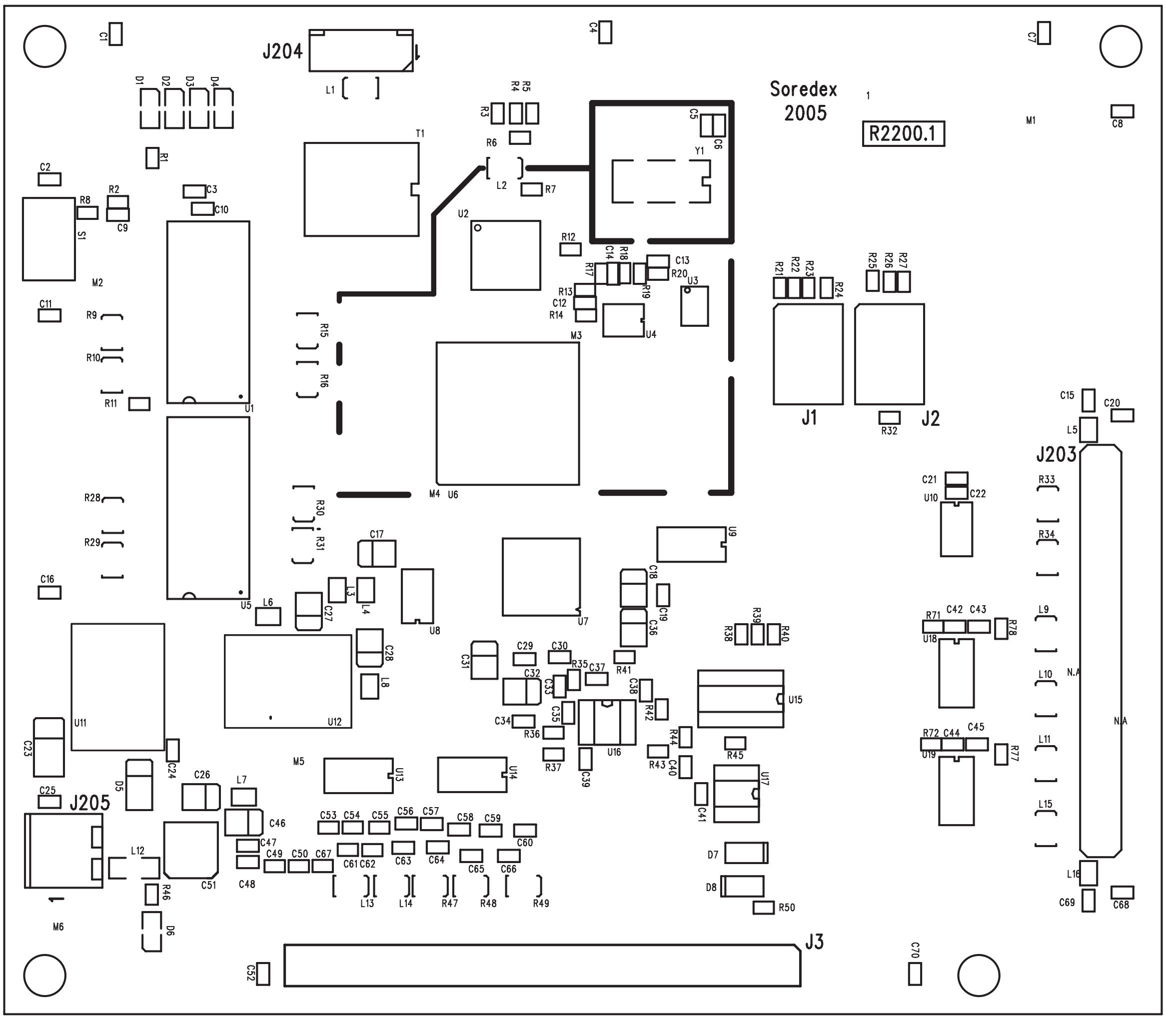

NCE
R24
10K
NCSO
+3V3
J1-2
J1-4
J1-6
J1-8
J1-10
NSTATUS
R21
10K
R23
10K
R22
10K
+3V3
DCLK
CONF_DONE
NCONFIG
DATA
ASD
J1-1
J1-3
J1-5
J1-7
J1-9
+3V3
J2-2
J2-4
J2-6
J2-8
J2-10
R32
1K0
R27
1K0
R26
1K0
+3V3
J2-1
J2-3
J2-5
J2-7
J2-9
TCK
TDO
TMS
TDI
R25
1k0
ALTERA Byte Blaster Connector/ JTAG connector

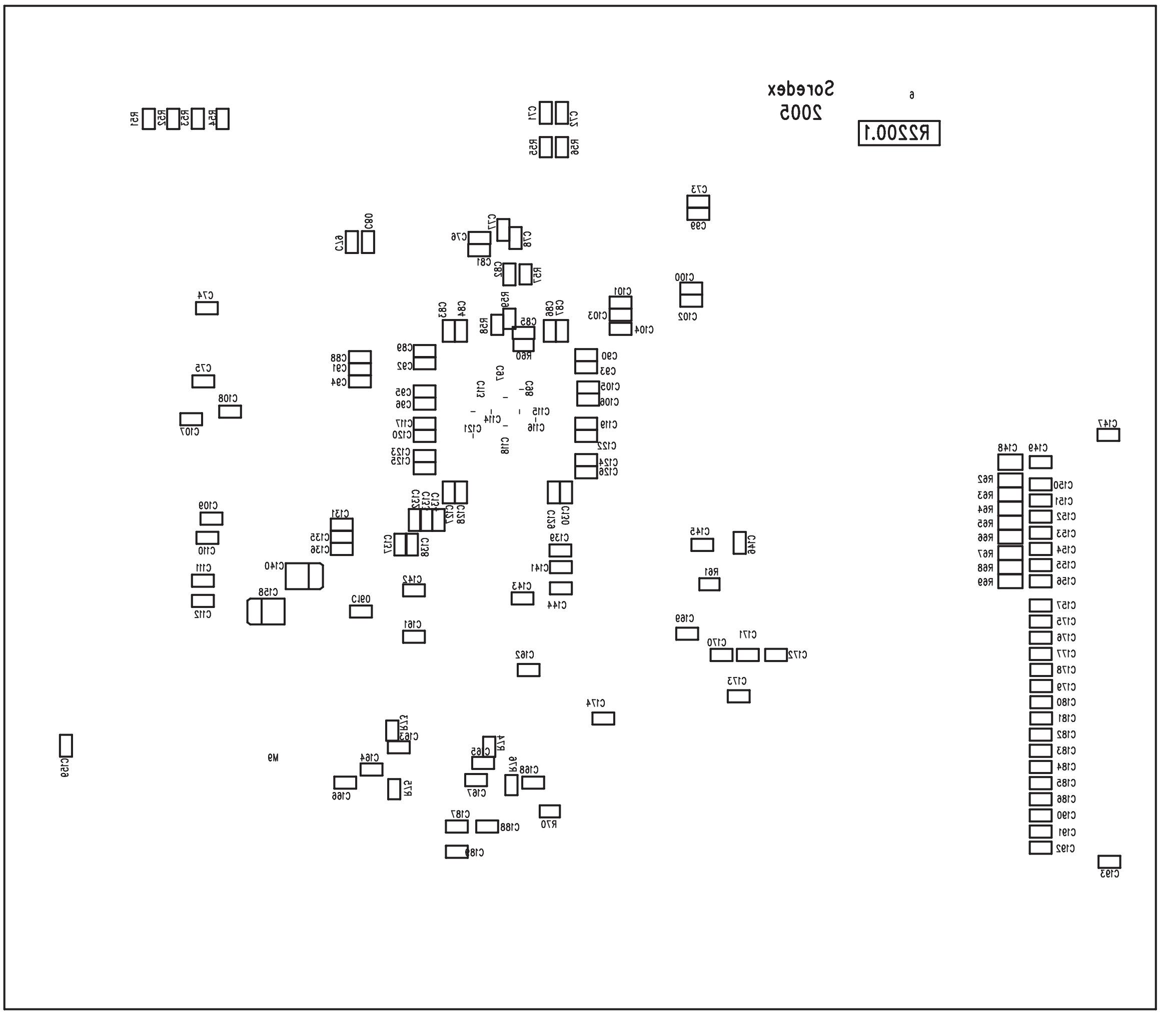

SP1
SP2
SP3
SP4
SP5
SP6
SP7
SP8
SP9
SP10
SP11
SP12
CLK_CYCLONE
CLK_ENETPHY
R58 56R
R12 56R
CLK2-CYCLONE
CLK2-ENETPHY
R14 56R
R17 56R
R13
R18
C12 0p 50V
C14 0p 50V
CLK1-CYCLONE
CLK1-ENETPHY
U4-C
U4-B
U4-A
SDRAM_CLK
R11 56R
PLL-OUT1
R59 56R
R60
C85 0p 50V
PLL-OUT
CLK-MAIN
R19 56R
C13 0p 50V
R20
Y1
OE GND VCC OUT
XO_SG636
+3V3_FPGA
U4-F
U4-E
U4-D
C99 100n 16V
C92 100n 16V
C6 100n 16V
C5 10n 50V
C135 10n 50V
C102 10n 50V
BYPASS for FLASH and CPLD
+3V3
C110 10n 50V
C101 10n 50V
C108 100n 16V


ADC14/AD9241
AD8042
MC14051B
74LVX3245TTR
74LVC244
RXD (from CCD Sensor)
connected to agnd at analog board
1M-2M signals


BYPASS for RESET CIRCUIT
HW_RESET-
FPGA_CLEAR-
(SW RESET)
VCCA2
LMS1587ES-3.3V
LMS1585-1.5V
POWER CONNECTOR +5V IN
J205-1
J205-2
Green
+3V3_FPGA
+1V5-CORE
+5V
+3V3



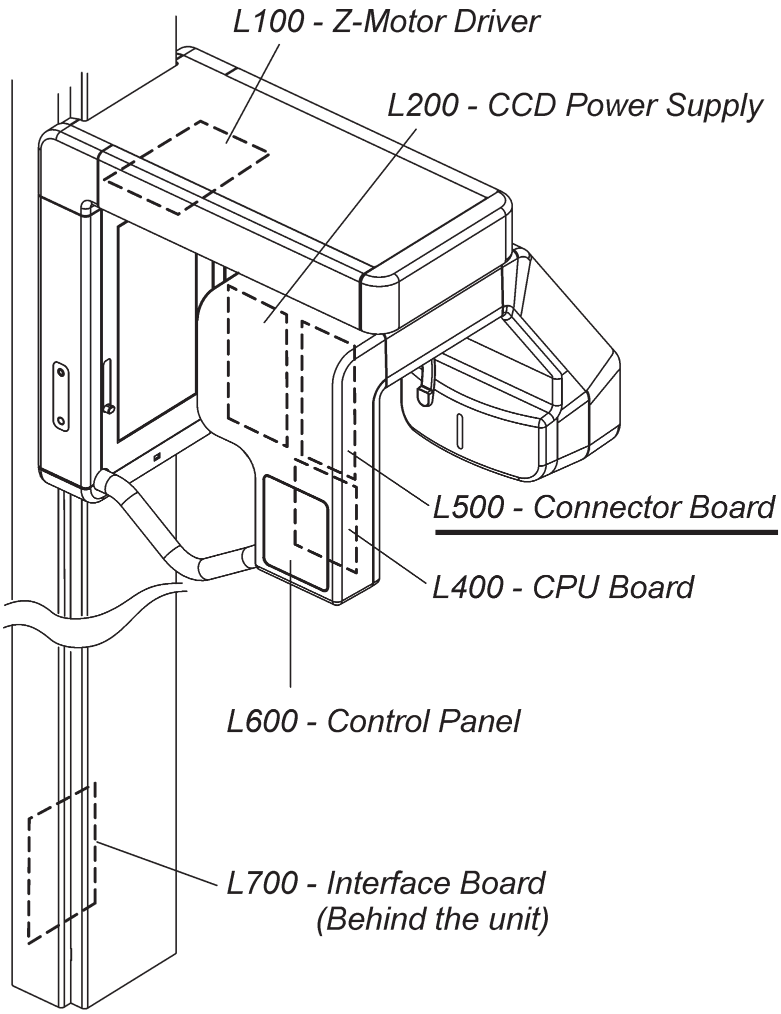

J204
Soredex
2005
R2200.1
J1
J2
J203
J205
J3



3.5 L500 Connector Board (Pt. no. 200399)

L500 - Location

In rotating unit on the the CCD sensor side. To access remove side cover left and the EMC shield (see section 7.1).



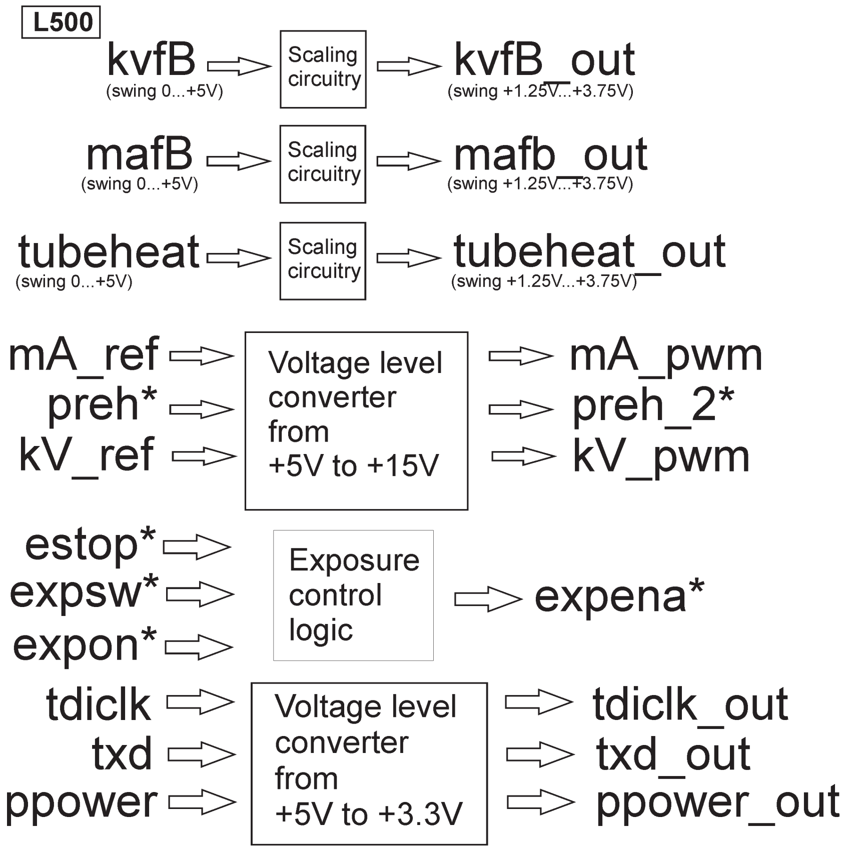
L500 - Field replaceable parts

None.

L500 - Description

L500 routes most of the signals to the other boards. L500 receives signals from the tubehead (kVfb, mafb, and tubeheat) and scales the voltage swing (0…+5V) linearly to (1.25V…3.75 V) which is the input for the A/D converter on the CPU board. L500 also includes external warning and ready light circuitry. The ESTOP signal enables stepper motor rotation and the exposure sequence.

L500 - Block Diagram



L500 - Test Points

Number	Description	Value
TP1	GND	0V
TP2	GND	0V

L500 - Connectors

J501

Pin	Signal	Description
1, 2	TUBEFAIL*	X-ray tube failure
3, 4	EXPENA*	Exposure enabled
5, 6	KVPWM	kV-reference
7, 8	GND	Ground
9, 10	KVFB	kV-feedback
11, 12	GND	Ground
13, 14	PREH_2*	Preheat
15, 16	MAPWM	mA-reference
17, 18	MAFB	mA-feedback
19, 20	TUBEHEAT	X-ray tube's temperature

J502

Pin	Signal	Description
1	HICUR*	High current selection
2	GND	GND (logic)
3	CLK*	Stepper motor clock
4	GND	GND (logic)
5	DIR*	Stepper motor direction
6	ENA*	Stepper motor enabled
7	+5.0VD2	Supply voltage
8	GND	GND (logic)

J503

Pin	Signal	Description
1	+5.0VD2	Supply voltage
2	+5.0VD2	Supply voltage
3	ESTOP*	Emergency stop
4	PL_ENA	Position lights enabled
5	ZENA*	Z-motor movement enabled
6	-	NOT USED
7	RETURN2*	Return membrane switch (side control panel)
8	MIRRORSW	Mirror switch
9	ZACT*	Z-movement activity
10	PLSW	Position light switch
11	EXPSW*	Exposure switch
12	GND	GND (logic)
13	RDYLT	Ready light
14	EXPLT	Exposure light
15	GND	GND (logic)
16	GND	GND (logic)

J504

Pin	Signal	Description
1	+5.0VD2	Supply voltage
2	ROTSW1	Rotation position optoswitch #1
3	ROTSW2	Rotation position optoswitch #2
4	GND	GND (logic)

J505

CAUTION:
When reconnecting this connector make sure that it is aligned correctly before switch the unit on. If the connector is misaligned the fuses on L200 may blow when the unit is switched on.

Pin	Signal	Description
1	GND	GND (logic)
2	GND	GND (logic)
3	D0	Data bit 0
4	D1	Data bit 1
5	D2	Data bit 2
6	D3	Data bit 3
7	D4	Data bit 4
8	D5	Data bit 5
9	-	NOT USED
10	-	NOT USED
11	HL	HIGH/LOW bit
12	VV	Valid video
13	-	NOT USED
14	IMAGE_OUT	Activates A/D conversion on CCD sensor board
15	TDICLK_OUT	Time Delay Integration
16	PPOWER_OUT	CCD sensor's supply voltages on CCD
17	-	NOT USED
18,20,21,23	GND	GND (logic)
19	DS	Data strobe
20	GND	GND (logic)
21	GND	GND (logic)
22	-	NOT USED
23	GND	GND (logic)
24	TXD_OUT	Transmit data (serial connection)
25	RXD	Receive data (serial connection)
26	RESET_CCD*	Resets the CCD sensor
27	-	NOT USED
28	-	NOT USED
29	-	NOT USED
30	-	NOT USED

31	PAN_CAM_DET	Panorama sensor mode, value +5.0VD2
32	PAN_CAM_DET	Panorama sensor mode, value +5.0VD2
33	-	NOT USED
34	-	NOT USED
35	+3.3VD_CCD	Supply voltage (CCD sensor's uC-voltage)
36	+3.3VD_CCD	Supply voltage (CCD sensor's uC-voltage)
37	GND	GND (logic)
38	GND	GND (logic)
39	GND	GND (logic)
40	GND	GND (logic)

J506

Pin	Signal	Description
1	+5.0VD2	Supply voltage
2	GND	GND (logic)
3	+3.3VD_CCD	Supply voltage (CCD sensor's continuous voltage)
4	GND	GND (logic)
5	REGTEMP	Regulator temperature
6	CCDENA	CCD enabled
7	LINEOK	Line voltage
8	FANPWM	Fan's PWM control

J507

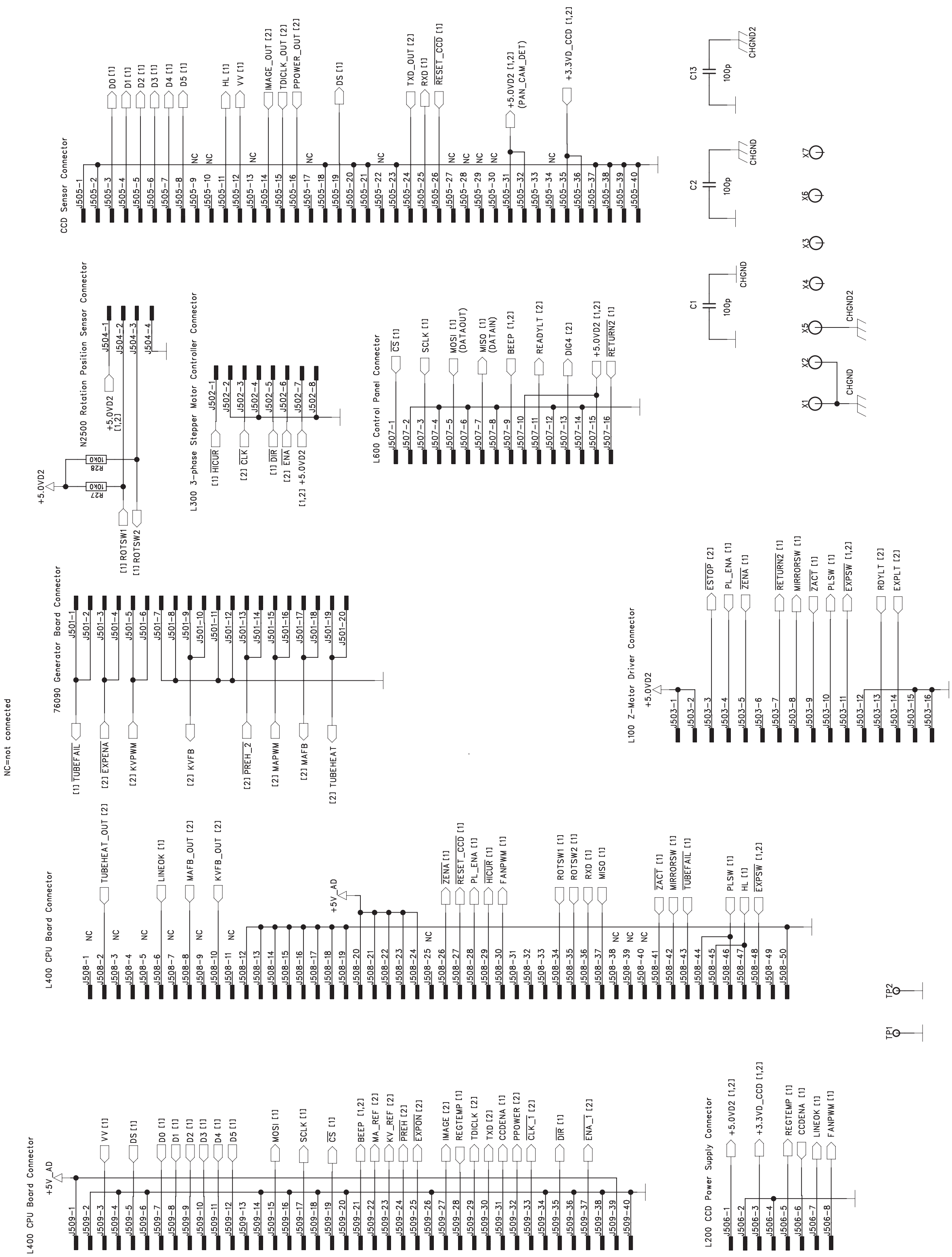
Pin	Signal	Description
1	CS*	Chip select
2	GND	GND (logic)
3	SCLK	SPI clock
4	GND	GND (logic)
5	MOSI	(Data out)
6	GND	GND (logic)
7	MISO	(Data in)
8	GND	GND (logic)
9	BEEP	Beeper control
10	+5.0VD2	Supply voltage
11	READYLT	Ready light
12	GND	GND (logic)
13	DIG4	Control voltage for external warning/exposure lights
14	GND	GND (logic)
15	+5.0VD2	Supply voltage
16	RETURN2*	Return membrane switch on side control panel

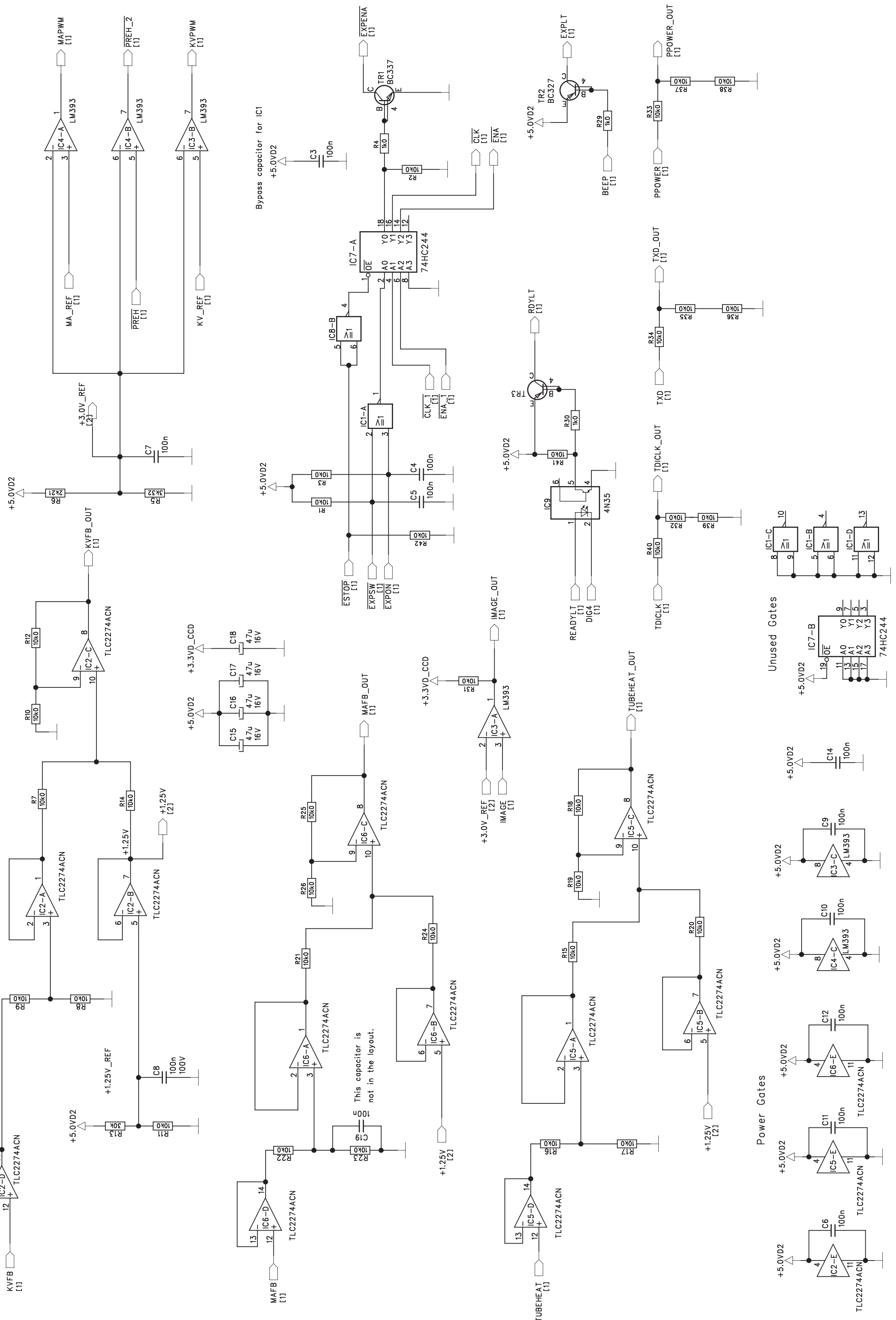
J508

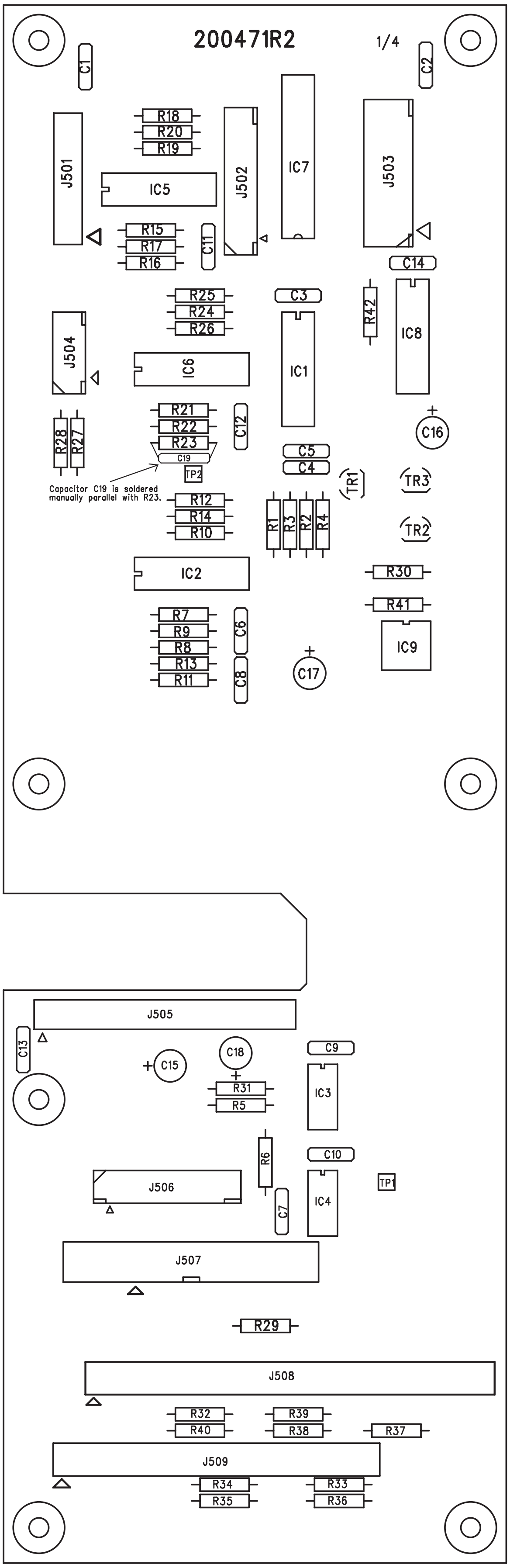
Pin	Signal	Description
1	-	NOT USED
2	TUBEHEAT_OUT	Tube head temperature
3	-	NOT USED
4	-	NOT USED
5	-	NOT USED
6	LINEOK	Line voltage level
7	-	NOT USED
8	MAFB_OUT	mA feedback
9	-	NOT USED
10	KVFB_OUT	kV feedback
11	-	NOT USED
12	GND (logic)	Ground
13	GND (logic)	Ground
14	GND (logic)	Ground
15	GND (logic)	Ground
16	GND (logic)	Ground
17	GND (logic)	Ground
18	GND (logic)	Ground
19	GND (logic)	Ground
20	+5V_AD	A/D converter's supply voltage
21	+5V_AD	A/D converter's supply voltage
22	+5V_AD	A/D converter's supply voltage
23	+5V_AD	A/D converter's supply voltage
24	+5V_AD	A/D converter's supply voltage
25	-	NOT USED
26	ZENA*	Z-motor movement enabled
27	RESET_CCD*	CCD sensor's reset
28	PL_ENA	Position lights enabled
29	HICUR*	High current selection
30	FANPWM	Fan control
31	-	NOT USED
32	-	NOT USED
33	-	NOT USED
34	ROTSW1	Rotation switch 1
35	ROTSW2	Rotation switch 2
36	RXD	Receive data (serial connection)
37	MISO	SPI signal
41	ZACT*	Z-movement activity
42	MIRRORSW	Mirror switch
43	TUBEFAIL*	X-ray tube failure
44	PLSW	Position light switch
45	HL	High/Low bit
46	PLSW	Position light switch
47	HL	High/Low bit
48	EXPSW*	Exposure switch
49	-	NOT USED
50	GND	GND (logic)

J509

Pin	Signal	Description
1	+5V_AD	AD converter's supply voltage
2	GND	GND (logic)
3	VV	Valid video
4	GND	GND (logic)
5	DS	Data strobe
6	GND	GND (logic)
7	D0	Data bit 0
8	D1	Data bit 1
9	D2	Data bit 2
10	D3	Data bit 3
11	D4	Data bit 4
12	D5	Data bit 5
13	-	NOT USED
14	GND	GND (logic)
15	MOSI	SPI signal
16	GND	GND (logic)
17	SCLK	SPI clock
18	GND	GND (logic)
19	CS*	Chip select
20	GND	GND (logic)
21	BEEP	Beeper control
22	MA_REF	Reference current
23	KV_REF	Reference voltage
24	PREH*	Preheat
25	EXPON*	Exposure on
26	GND	GND (logic)
27	IMAGE	Activates A/D conversion on CCD sensor
28	REGTEMP	Regulator temperature
29	TDICLK	Time Delay Integration clock
30	TXD	Transmit data (serial connection)
31	CCDENA	Activates CCD the supply voltages
32	PPOWER	CCD sensor's supply voltages
33	CLK_1*	Stepper motor clock
34	GND	GND (logic)
35	DIR*	Stepper motor direction
36	GND	GND (logic)
37	ENA_1*	Stepper motor enable
38	GND	GND (logic)
39	+5V_AD	AD converter's supply voltage
40	GND	GND (logic)


CCD Sensor Connector
N2500 Rotation Position Sensor Connector
L300 3-phase Stepper Motor Controller Connector
L600 Control Panel Connector
76090 Generator Board Connector
L100 Z-Motor Driver Connector
L400 CPU Board Connector
L400 CPU Board Connector
L200 CCD Power Supply Connector
NC=not connected

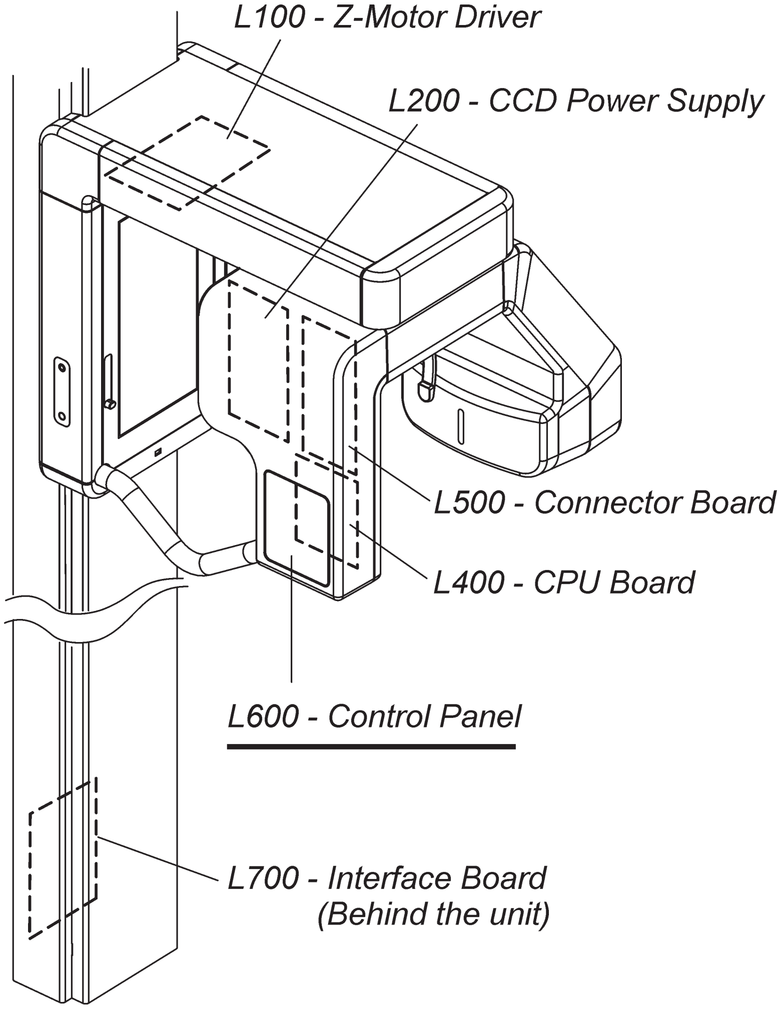

MAPWM
PREH_2
KVPWM
EXPENA
EXPLT
PPOWER_OUT
Bypass capacitor for IC1
MA_REF
PREH
KV_REF
CLK
ENA
BEEP
PPOWER
TXD_OUT
TXD
RDYLT
TDICLK_OUT
TDICLK
ESTOP
EXPSW
EXPON
CLK_1
ENA_1
READYLT
DIG4
+3.0V_REF
KVFB_OUT
IMAGE_OUT
MAFB_OUT
TUBEHEAT_OUT
IMAGE
Unused Gates
Power Gates
This capacitor is not in the layout.
+1.25V_REF
KVFB
MAFB
TUBEHEAT
LM393
TLC2274ACN
74HC244
BC337
BC327
4N35
+5.0VD2
+3.3VD_CCD
+1.25V


200471R2
1/4
C1
C2
R18
R20
R19
J501
IC5
J502
IC7
J503
R15
R17
R16
C11
C14
R25
R24
R26
C3
R42
IC8
J504
IC6
IC1
R21
R22
R23
C19
C12
TP2
R28
R27
C16
C5
C4
TR1
TR3
Capacitor C19 is soldered manually parallel with R23.
R12
R14
R10
R1
R3
R2
R4
TR2
IC2
R30
R41
R7
R9
R8
R13
R11
C6
C8
C17
IC9
J505
C13
C15
C18
C9
R31
R5
IC3
R6
C10
J506
TP1
IC4
C7
J507
R29
J508
R32
R40
R39
R38
R37
J509
R34
R35
R33
R36

3.6 L600 Control Panel (Pt. no. 200400)

L600 - Location

In rotating unit on the the CCD sensor side. To access remove left side cover (see section 7.1).



L600 - Field replaceable parts

None.

L600 - Description

L600 monitors the state of the membrane switches, converts the signals from parallel to serial and sends them to the CPU board via the SPI (**S**erial **P**heripheral **I**nterface). An 8-bit LED display driver controls three 3.4mm x 2.4mm seven segment displays and several indicator LEDs.

L600 - Indicator LEDs

LED	Colour	Indicates
D2	red/green	PC LED. Green = connection Red = No connection Orange = Data transfer
D3	red/green	PC LED (As above)
D4	red/green	PC LED (As above)
D5	red/green	PC LED (As above)
D6	green	Tube voltage 60kV
D7	green	Tube voltage 70kV
D8	green	TMJ imaging
D9	green	Patient size child
D10	green	Patient size adult
D11	green	Drive rotating unit to the PIO position
D12	green	Test program without x-rays

L600 - Test Points

Number	Description	Value
TP1	GND	0V

L600 - Connectors

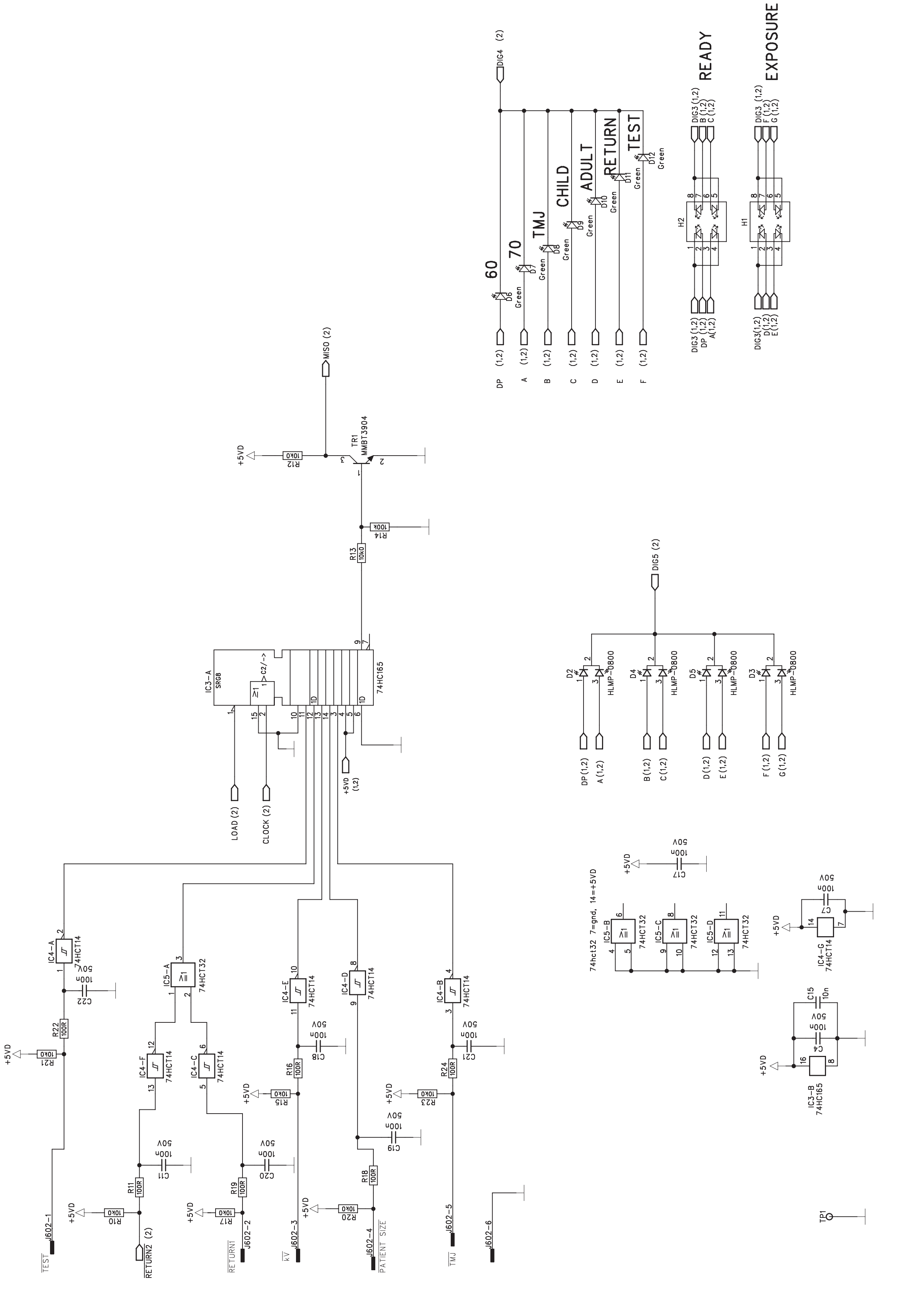
J601

Pin	Signal	Description
1	CS*	Chip select
2	GND	GND
3	SCLK	SPI clock
4	GND	GND
5	MOSI	SPI signal
6	GND	GND
7	MISO	SPI signal
8	GND	GND
9	BEEP*	Beeper control
10	+5V	Power supply

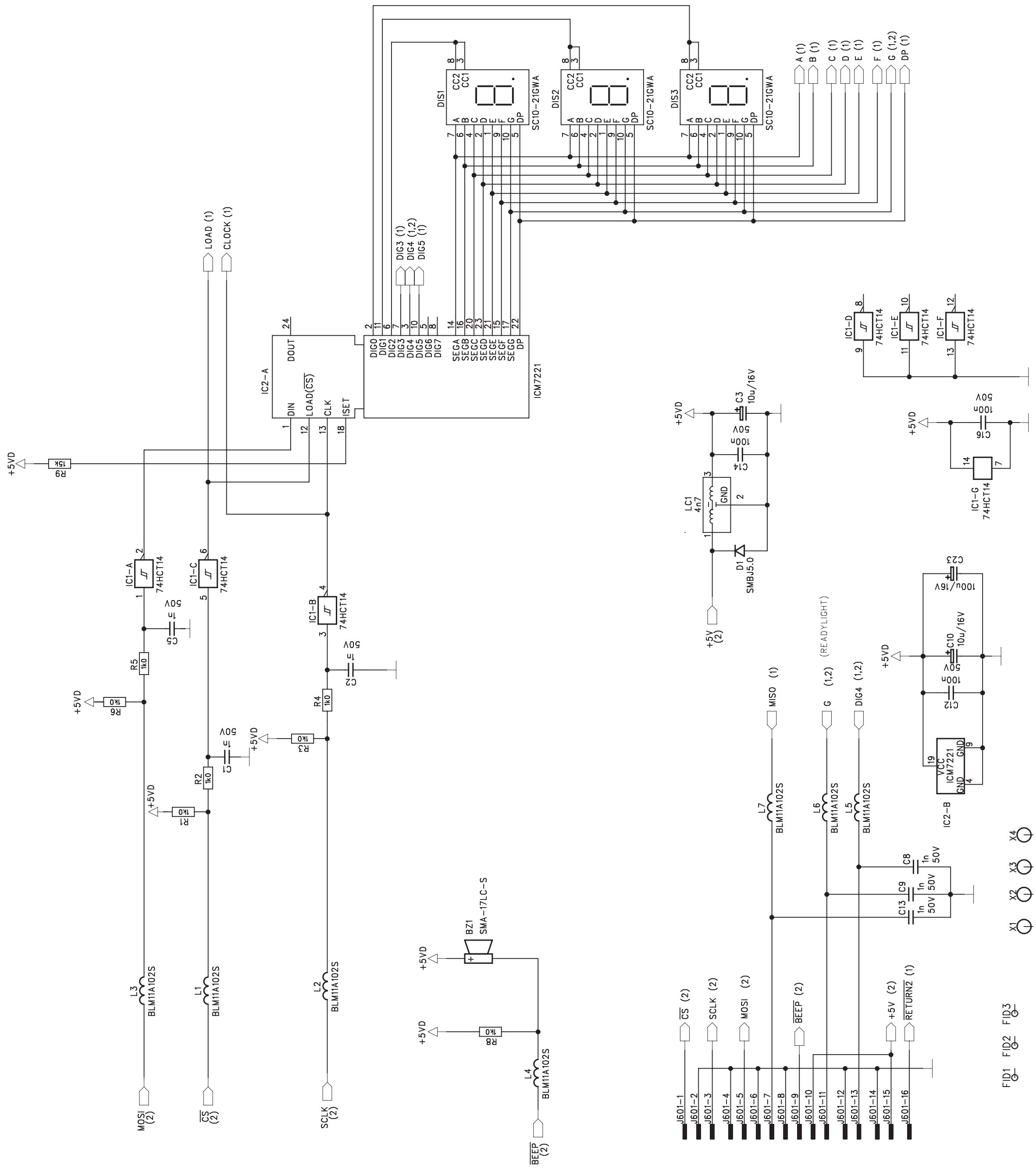
11	Readylight	
12	GND	GND
13	DIG4	Cathode voltage of the LEDs
14	GND	GND
15	+5V	Power supply
16	RETURN2*	Return membrane switch (side control panel)

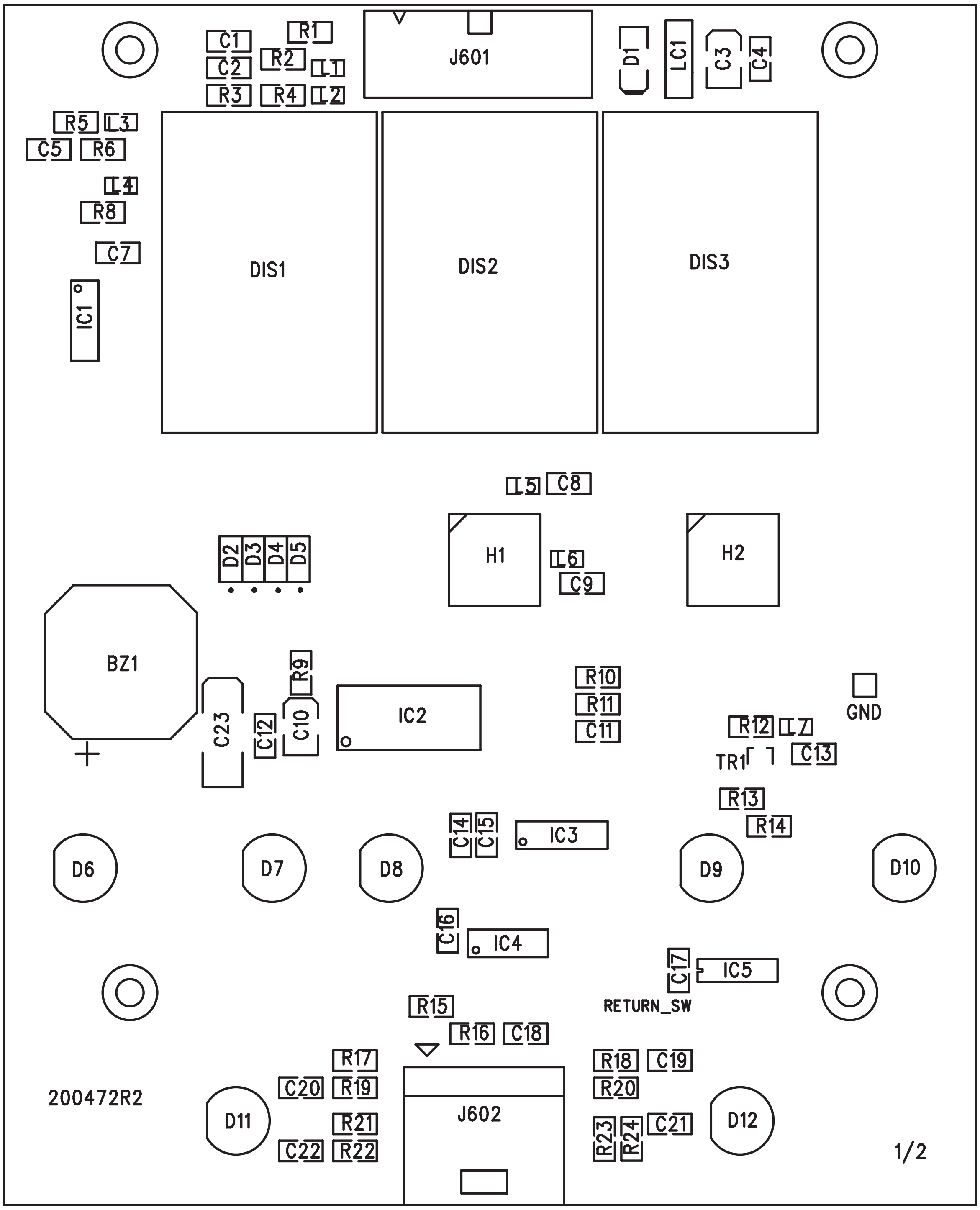
J602

Pin	Signal	Description
1	TEST*	Test key pressed
2	RETURN1*	Return key pressed
3	kV*	Voltage selection key pressed
4	PATIENT SIZE*	Patient size key pressed
5	TMJ*	TMJ imaging key pressed
6	GND	GND



60
70
TMJ
CHILD
ADULT
RETURN
TEST
READY
EXPOSURE
DIG4 (2)
DIG5 (2)
MISO (2)
TR1 MMBT3904
IC3-A SRG8
74HC165
LOAD (2)
CLOCK (2)
74hct32 7=gnd, 14=+5VD
TEST
RETURN2 (2)
RETURN1
kV
PATIENT SIZE
TMJ
J602-1
J602-2
J602-3
J602-4
J602-5
J602-6
TP1

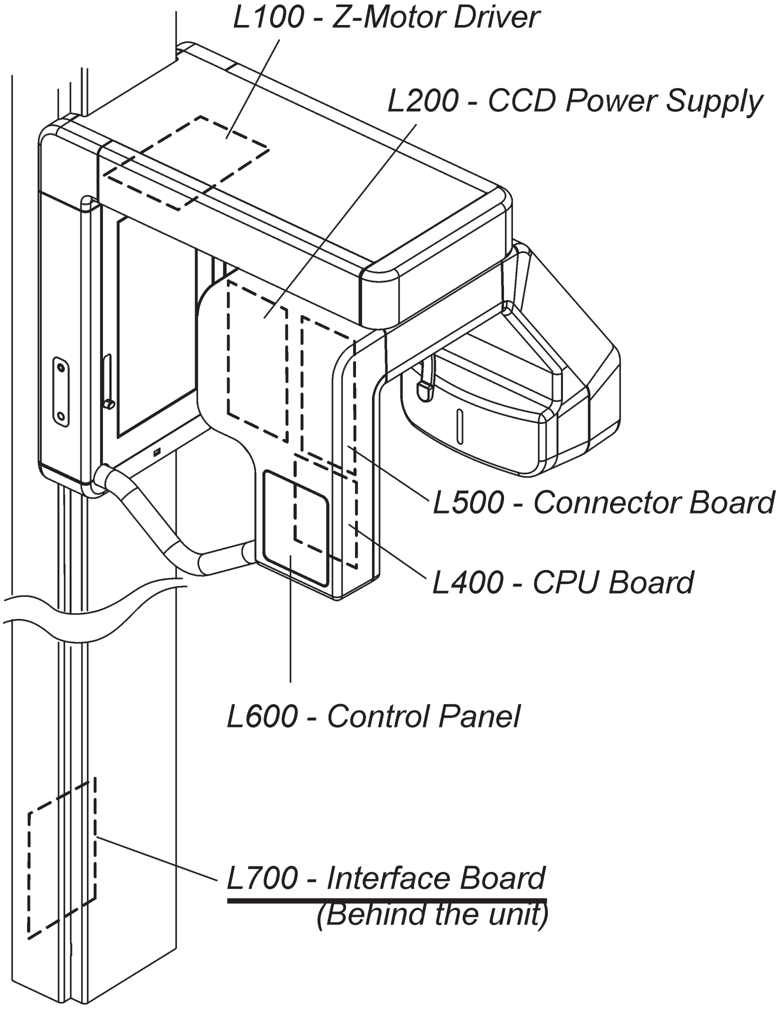

DIS1
DIS2
DIS3
SC10-21GWA
A (1)
B (1)
C (1)
D (1)
E (1)
F (1)
G (1,2)
DP (1)
LOAD (1)
CLOCK (1)
DIG3 (1)
DIG4 (1,2)
DIG5 (1)
IC2-A
ICM7221
DIN
LOAD(CS)
CLK
ISET
DOUT
IC1-A
IC1-B
IC1-C
IC1-D
IC1-E
IC1-F
IC1-G
74HCT14
+5VD
R9
15k
C3
10u/16V
C14
100n
50V
LC1
4n7
GND
D1
SMBJ5.0
+5V
(2)
C16
100n
50V
C23
100u/16V
C10
10u/16V
C12
100n
50V
(READYLIGHT)
MISO (1)
G (1,2)
DIG4 (1,2)
IC2-B
ICM7221
VCC
GND
L7
L6
L5
BLM11A102S
C8
C9
C13
1n
50V
X1
X2
X3
X4
R1
R2
R3
R4
R5
R6
1k0
C1
C2
C5
1n
50V
L1
L2
L3
L4
MOSI
(2)
CS
SCLK
BZ1
SMA-17LC-S
R8
BEEP
CS (2)
SCLK (2)
MOSI (2)
BEEP (2)
+5V (2)
RETURN2 (1)
J601-1
J601-2
J601-3
J601-4
J601-5
J601-6
J601-7
J601-8
J601-9
J601-10
J601-11
J601-12
J601-13
J601-14
J601-15
J601-16
FID1
FID2
FID3


C1
R1
J601
D1
LC1
C3
C4
C2
R2
L1
R3
R4
L2
R5
L3
C5
R6
L4
R8
C7
DIS1
DIS2
DIS3
IC1
L5
C8
D2
D3
D4
D5
H1
L6
C9
H2
BZ1
R9
C23
C12
C10
IC2
R10
R11
C11
GND
R12
L7
TR1
C13
R13
R14
C14
C15
IC3
D6
D7
D8
D9
D10
C16
IC4
C17
IC5
RETURN_SW
R15
R16
C18
R17
R18
C19
200472R2
C20
R19
R20
J602
D11
R21
R23
R24
C21
D12
C22
R22
1/2

3.7 L700 Interface Board (Pt. no. 200401)

L700 - Location

At the rear of the column near the base. To access remove the cover from the front of the column.



L700 - Field replaceable parts

None.

L700 - Description

L700 serves as an external interface to the outside environment. The Ethernet cable that goes to the PC and the exposure button cable are connected to this board.

L700 - Connectors

J701

Pin	Signal	Description
1	EXPSW*	Exposure switch
2	READYLT	Ready light
3	EXPLT	Exposure light
4	GND	GND
5	-	NOT USED
6	GND	GND

J702

Pin	Signal	Description
1	EXPSW*	Exposure switch
2	EXPSW_LOCK*	Exposure switch

J703

Pin	Signal	Description
1	EXPSW_LOCK*	Exposure switch
2	READYLT	Ready light
3	EXPLT	Exposure light
4	GND	GND
5	-	NOT USED
6	GND	GND

J704

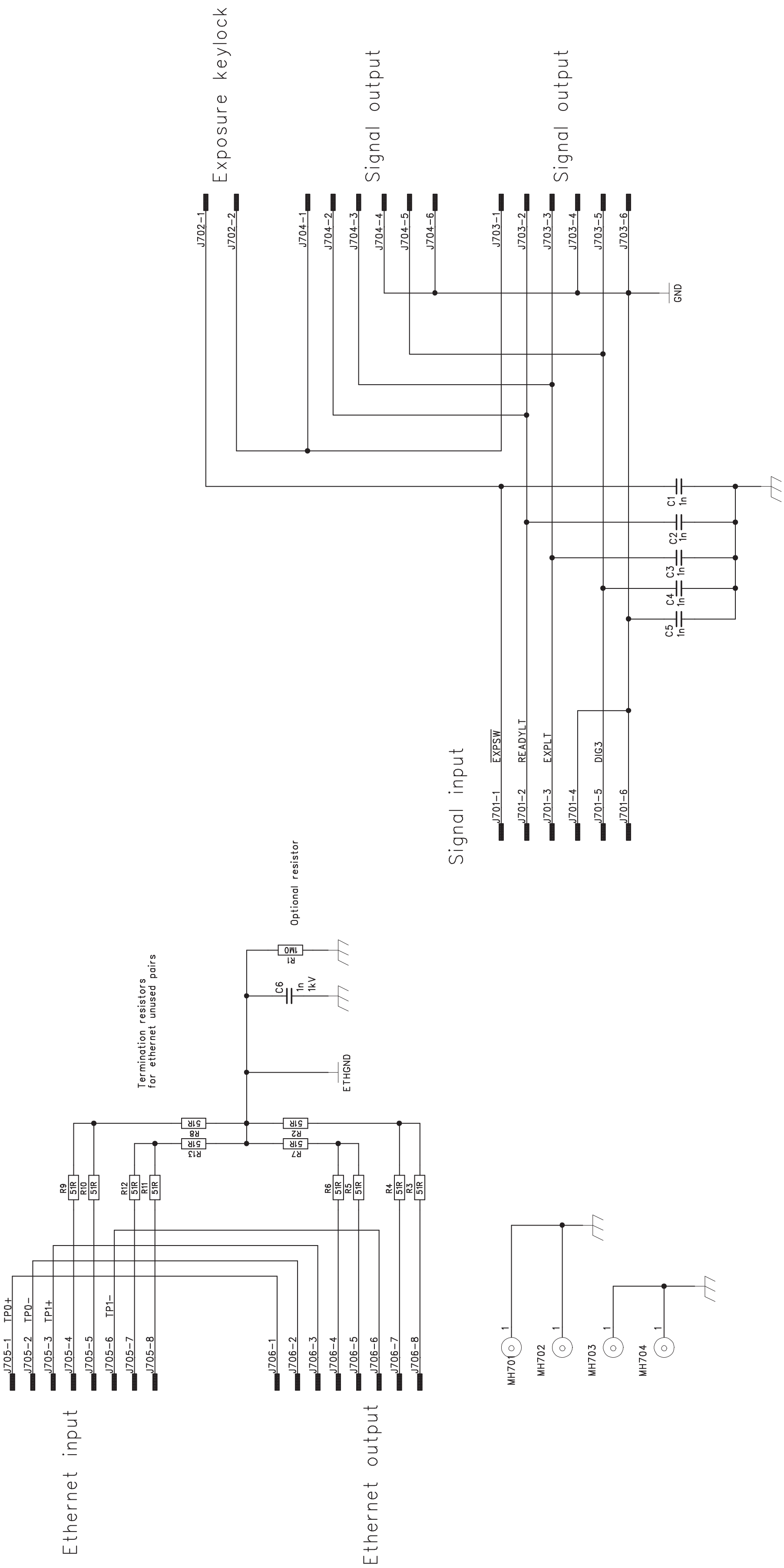
Pin	Signal	Description
1	EXPSW_LOCK*	Exposure switch
2	READYLT	Ready light
3	EXPLT	Exposure light
4	GND	GND
5	-	NOT USED
6	GND	GND

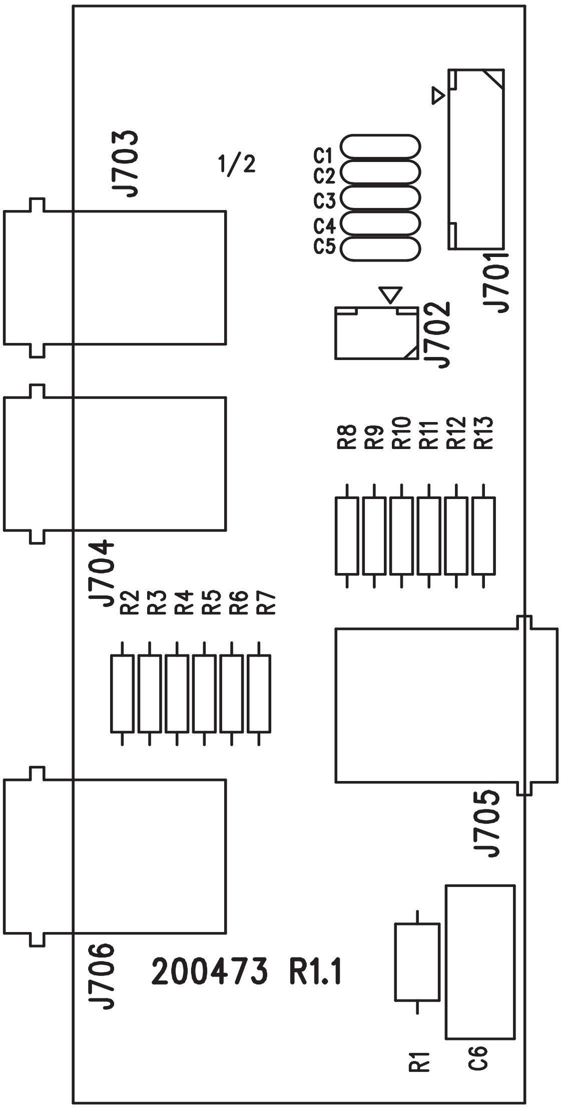
J705

Pin	Signal	Description
1	TP0+	Ethernet, twisted pair 0
2	TP0-	Ethernet, twisted pair 0
3	TP1+	Ethernet, twisted pair 1
4	-	NOT USED
5	-	NOT USED
6	TP1-	Ethernet, twisted pair 1
7	-	NOT USED
8	-	NOT USED

J706

Pin	Signal	Description
1	TP0+	Ethernet, twisted pair 0
2	TP0-	Ethernet, twisted pair 0
3	TP1+	Ethernet, twisted pair 1
4	-	NOT USED
5	-	NOT USED
6	TP1-	Ethernet, twisted pair 1
7	-	NOT USED
8	-	NOT USED

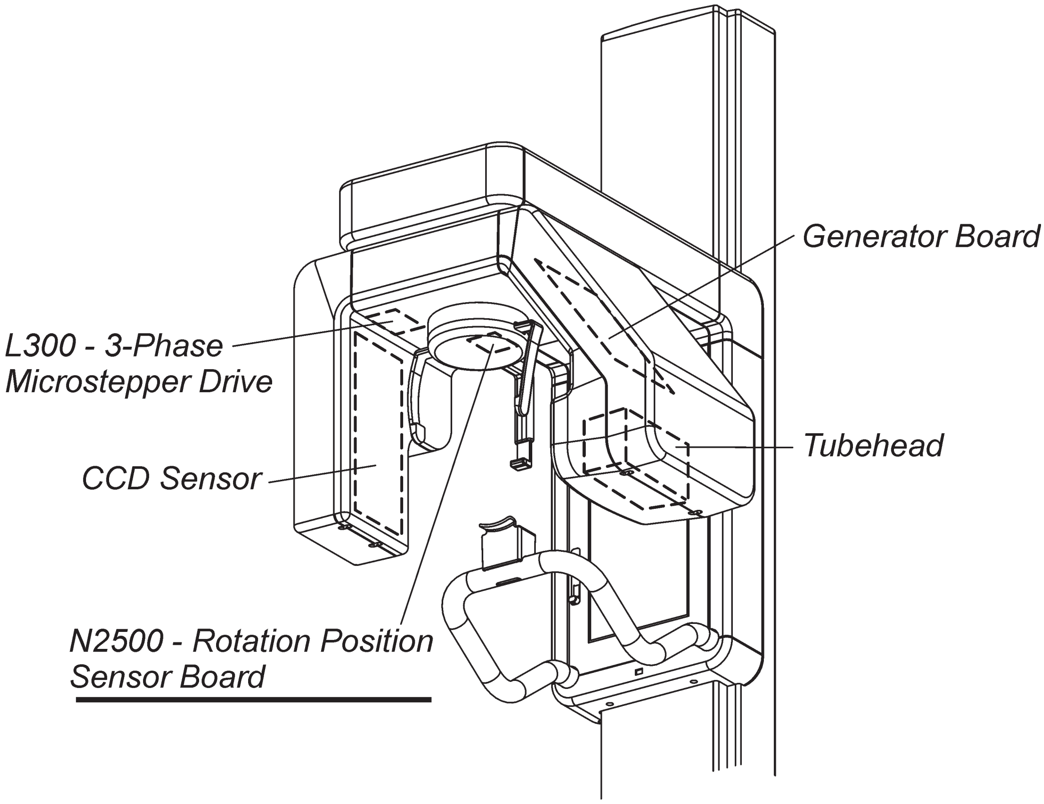

Exposure keylock
Signal output
Signal output
J702-1
J702-2
J704-1
J704-2
J704-3
J704-4
J704-5
J704-6
J703-1
J703-2
J703-3
J703-4
J703-5
J703-6
GND
C1 1n
C2 1n
C3 1n
C4 1n
C5 1n
Signal input
EXPSW
READYLT
EXPLT
DIG3
J701-1
J701-2
J701-3
J701-4
J701-5
J701-6
Optional resistor
R1 1M0
C6 1n 1kV
Termination resistors for ethernet unused pairs
ETHGND
R8 51R
R13 51R
R2 51R
R7 51R
R9 51R
R10 51R
R12 51R
R11 51R
R6 51R
R5 51R
R4 51R
R3 51R
TP0+
TP0-
TP1+
TP1-
J705-1
J705-2
J705-3
J705-4
J705-5
J705-6
J705-7
J705-8
J706-1
J706-2
J706-3
J706-4
J706-5
J706-6
J706-7
J706-8
MH701
MH702
MH703
MH704
Ethernet input
Ethernet output


J703
1/2
C1
C2
C3
C4
C5
J701
J702
J704
R2 R3 R4 R5 R6 R7
R8 R9 R10 R11 R12 R13
J705
J706
200473 R1.1
R1
C6

3.8 N2500 Rotation Position Sensor Board (Pt. no. 4801143)

N2500 - Location

Inside the rotating unit under the head support. To access, remove the head support and then the lower protective cover (see section 7.1).



N2500 - Field replaceable parts

None.

N2500 - Description

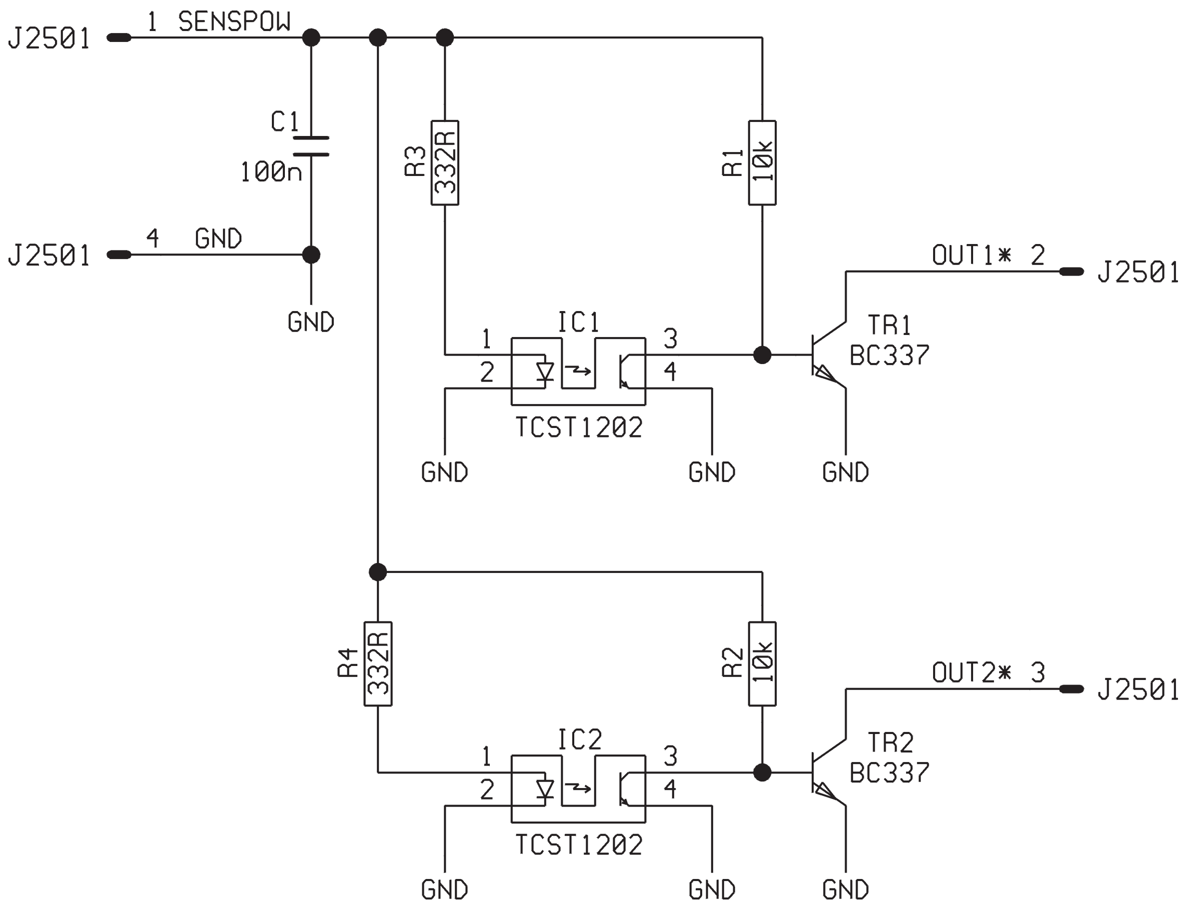
N2500 is used to detect the position of the rotating unit. N2500 has two optical switches that generate sensor signals ROTSW1 and ROTSW2 according to which position is activated.

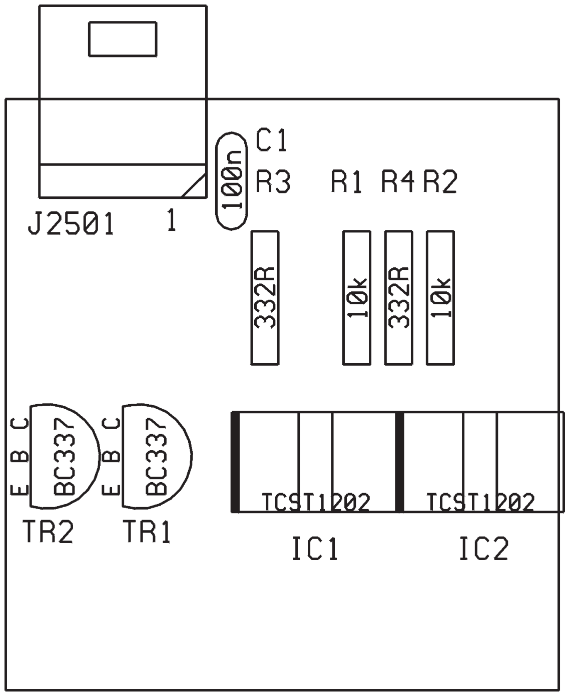
N2500 includes a transmitter LED, and a receiver, or base. The sensor signals remain on as long as the base receives light from the LED. When the light to the base is cut off by the positioning rail, the sensor signal is switched off.

N2500 - Connectors

J2501

Pin	Signal	Description
1	+5V	Supply voltage
2	ROTSW1	Sensor signal 1
3	ROTSW2	Sensor signal 2
4	GND	Ground


J2501
1 SENSPOW
C1
100n
J2501
4 GND
GND
R3
332R
R1
10k
OUT1* 2
J2501
IC1
1
2
3
4
TR1
BC337
TCST1202
GND
GND
GND
R4
332R
R2
10k
OUT2* 3
J2501
IC2
1
2
3
4
TR2
BC337
TCST1202
GND
GND
GND


C1
100n
R3
R1
R4
R2
J2501
1
332R
10k
332R
10k
E B C
BC337
E B C
BC337
TR2
TR1
TCST1202
TCST1202
IC1
IC2

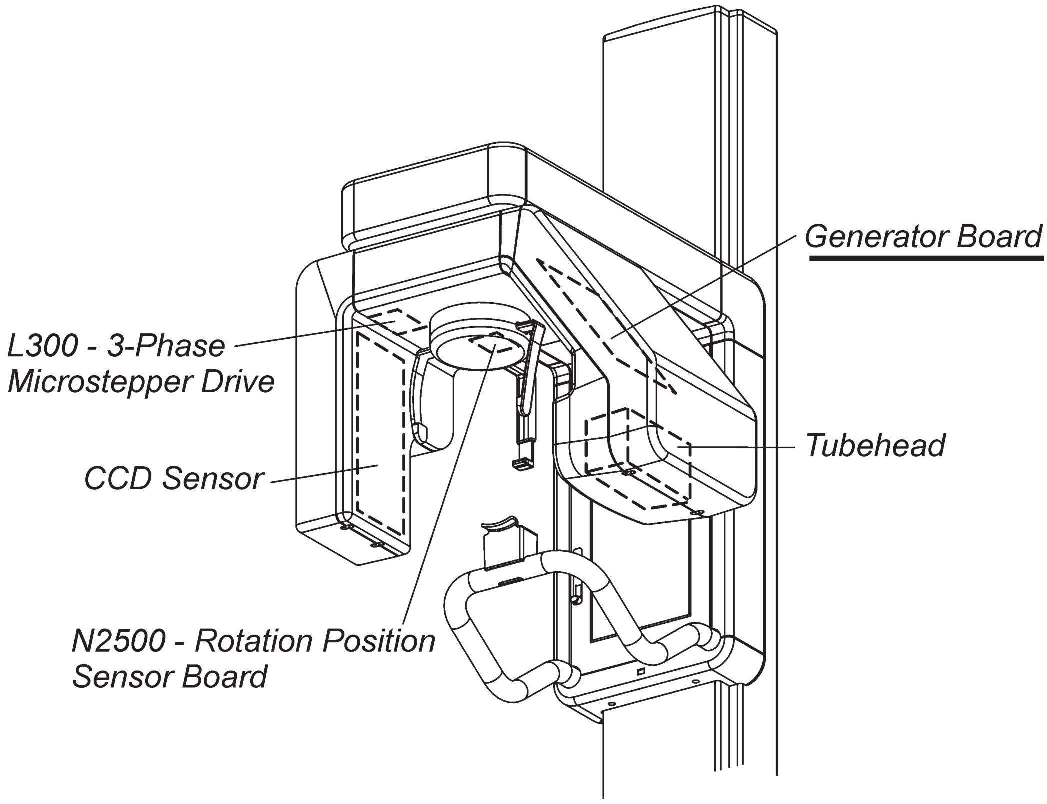
3.9 Generator Board (Pt. no. 200404)

DANGER: HIGH VOLTAGE

WARNING:
Do not touch the Generator Board until the capacitors have discharged. After switching the unit off wait 10 minutes for the capacitors to discharge. When lamp LA1 goes out the capacitors are discharged.

Gen. brd - Location

In rotating unit on the the tubehead side. To access remove the side cover right (see section 7.1).



Gen. brd - Field replaceable parts

Fuse FH1,
1amp, 230VAC
or
1.6amp, 115VAC.

Gen. brd - Description

The Generator board receives kV and mA reference signals from L400 as digital values. Based on the kV-reference value, the Generator board generates the corresponding high voltage between the cathode and anode of the x-ray tube. Based on milliampere reference value, the generator board generates preheat current (to warm up the filament before x-rays are switched on) and filament current (during exposure). The Generator board receives kV and mA feedback signals from the tubehead that are used to monitor and adjust the generated values. The Generator board produces its own supply voltages.

Gen. brd - Indicator lights

LED	Colour	Indicates
LA1	Orange	+310V (capacitors charged)
H1	Green	+5V
H2	Green	+15V
H3	Yellow	Exposure
H4	Red	Tube fail
H5	Yellow	Preheat
H6	Green	+15V

Gen. brd - Test Points

Number	Signal	Value
TP1		+34V
TP2		+5V
TP3	GND	0V
TP4		+15V
TP5	-	NOT USED
TP6	-	NOT USED
TP7	HVGND	0V
TP8		+24V
TP9	VDD	+15V
TP10	-	NOT USED
TP11	mAREF	1V = 20kV
TP12	kVREF	1V = 20kV; thus 3V=60kV and 3.5V=70kV
TP13	-	NOT USED
TP14	kVFB	1V = 20kV; thus 3V=60kV and 3.5V=70kV
TP15	EXPENA	on to enable off to disable

TP16	-	NOT USED
TP17	GND	0V
TP18	mAFB	2V @ 7mA
TP19	Tubeheat	
TP20	-	NOT USED
TP21	-	NOT USED
TP22	HVGND	0V
TP23	HV310	310V

Gen. brd - Connectors

X43

Pin	Signal	Description
1	27VAC (+)	Secondary transformer winding for 27VAC
2	27VAC (+)	Secondary transformer winding for 27VAC
3	27VAC (-)	Secondary transformer winding for 27VAC
4	27VAC (-)	Secondary transformer winding for 27VAC

X44

Pin	Signal	Description
1	19VAC (+)	Secondary transformer winding for 19VAC
2	19VAC (-)	Secondary transformer winding for 19VAC

X45 (230VAC)

Pin	Signal	Description
1	-	NOT USED
2	N	Neutral
3	-	NOT USED
4	-	NOT USED
5	L	Line (230VAC)
6	-	NOT USED

X46 (115VAC)

Pin	Signal	Description
1	-	NOT USED
2	N	Neutral
3	N	Neutral
4	-	NOT USED
5	L	Line (115VAC)
6	L	Line (115VAC)

X47

Pin	Signal	Description
1	N	Neutral (from mains switch)
2	-	NOT USED
3	L	Line (from mains switch)
4	-	NOT USED

X48

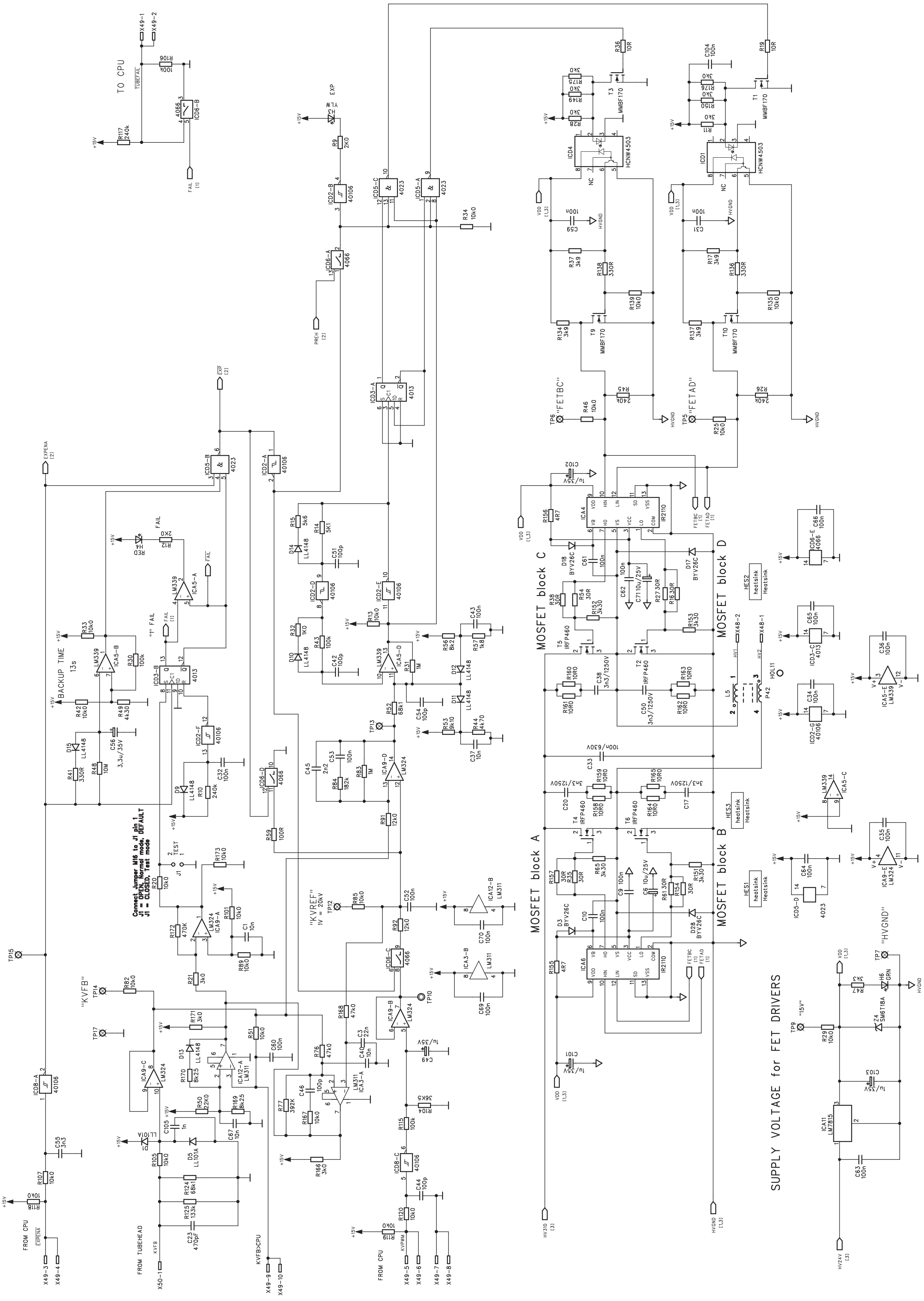
Pin	Signal	Description
1	HV2	310V tube voltage (60 or 70kV)
2	HV1	310V tube voltage (60 or 70kV)

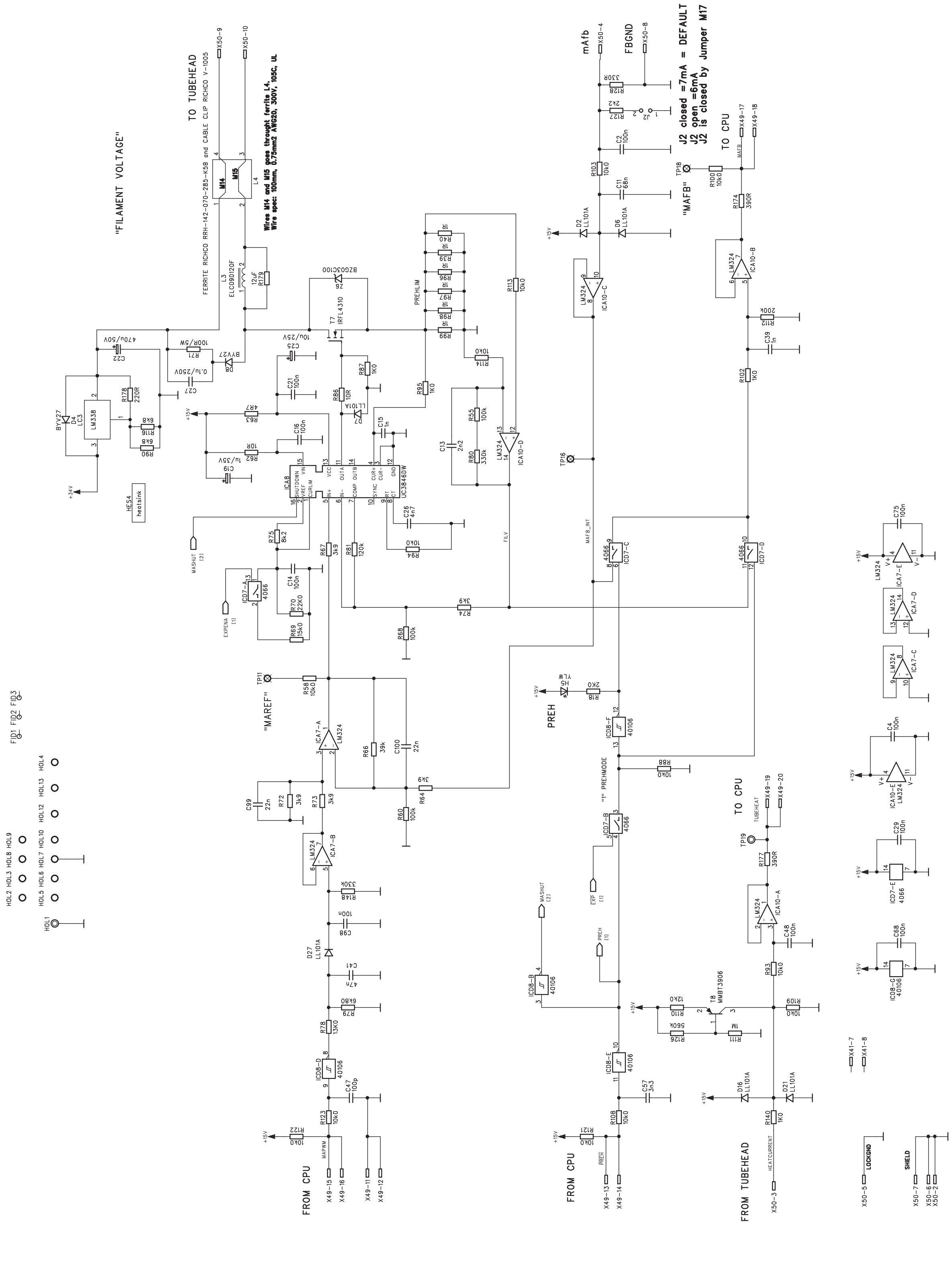
X49

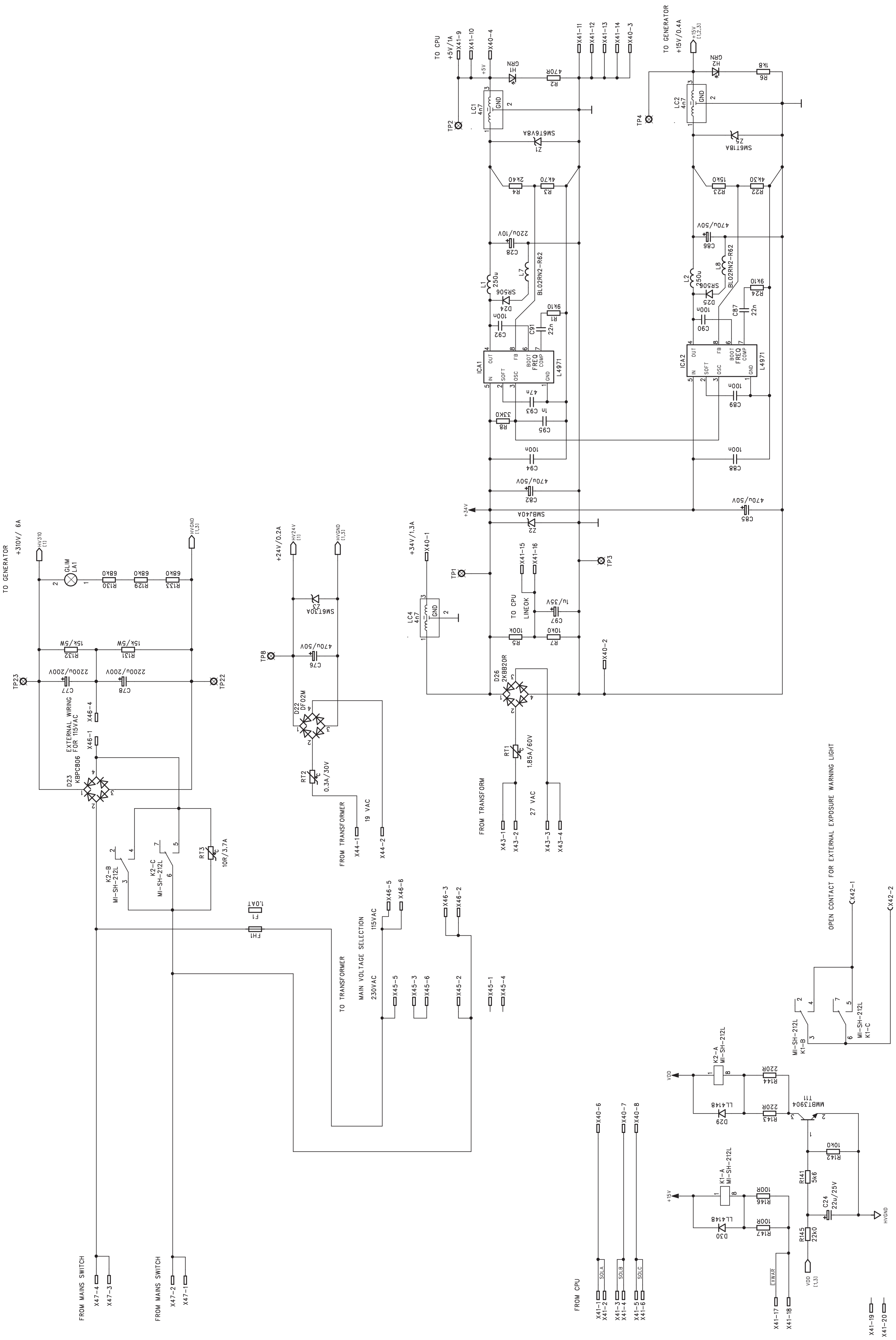
Pin	Signal	Description
1, 2	TUBEFAIL*	X-ray tube failure
3, 4	EXPENA*	Exposure enabled
5, 6	KVPWM	kV reference (a PWM-signal)
7, 8	GND	Ground
9, 10	KVFB	kV feedback
11, 12	GND	Ground
13, 14	PREH_2*	Preheat
15, 16	MAPWM	mA reference (a PWM-signal)
17, 18	MAFB	mA feedback
19, 20	TUBEHEAT	X-ray tube's temperature

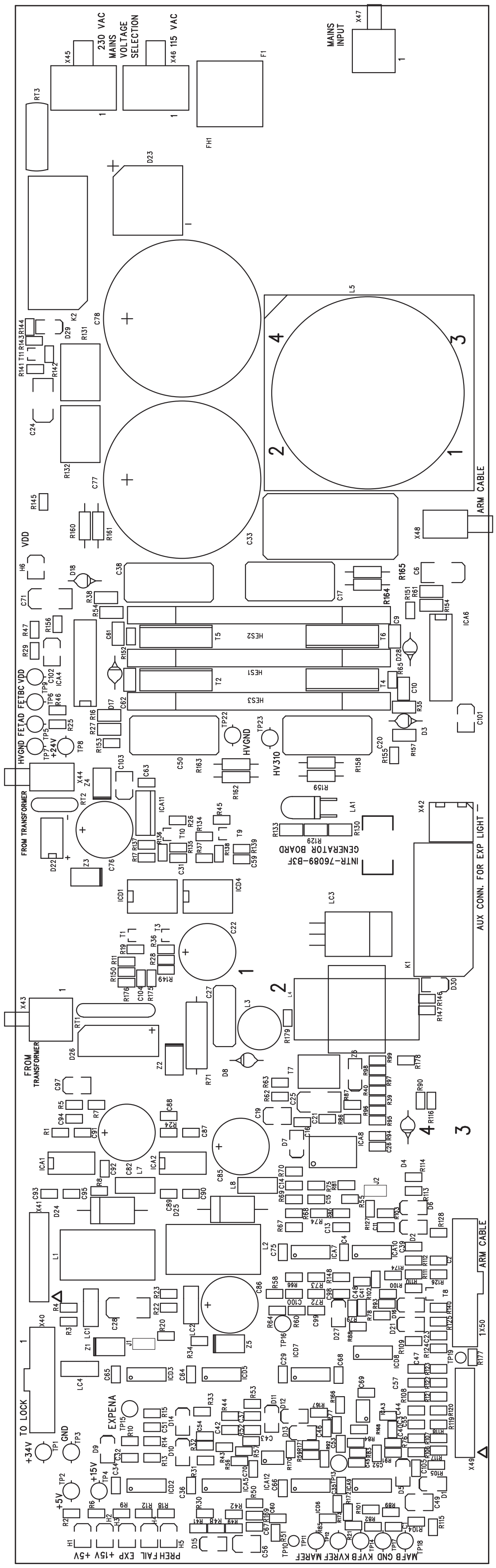
X50

Pin	Signal	Description
1	KVFB	kV-feedback
2	GND	Ground
3	HEATCURRENT	Tube temperature
4	MAFB	mA feedback
5 - 8	GND	Ground
9	FILAMENT VOLTAGE (+)	
10	FILAMENT VOLTAGE (-)	




"FILAMENT VOLTAGE"
TO TUBEHEAD
TO CPU
"MAFB"
"MAREF"
PREH
FROM CPU
FROM CPU
TO CPU
FROM TUBEHEAD

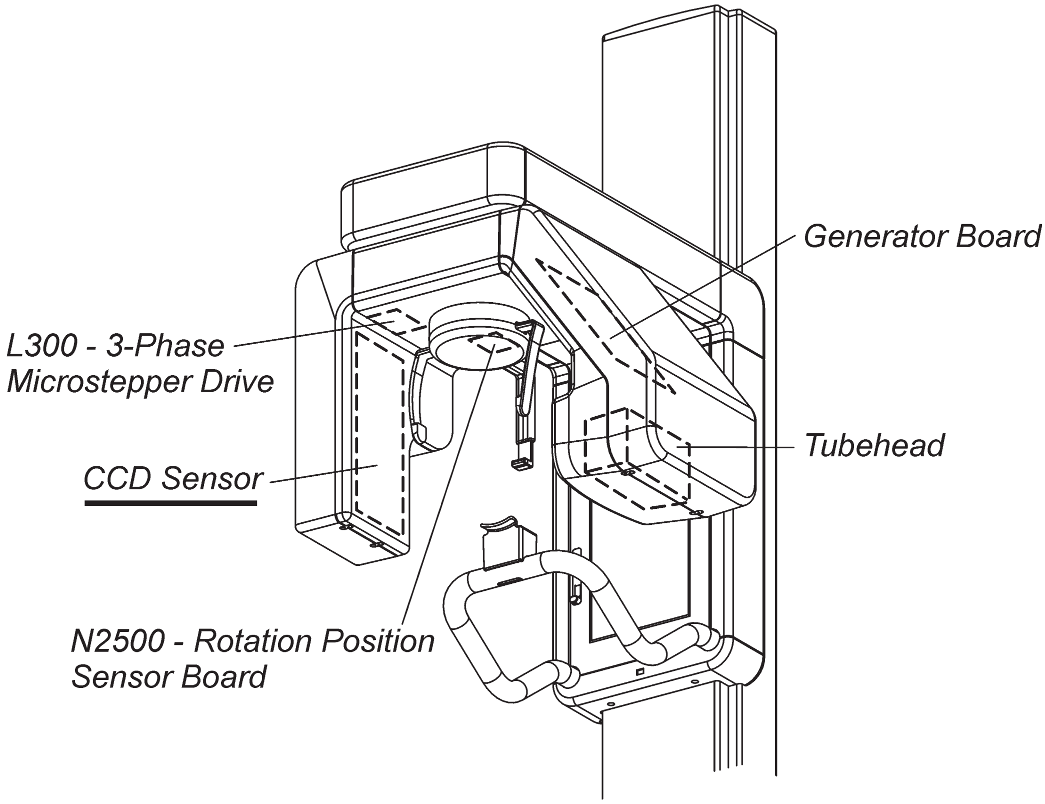




3.10 CCD Sensor (Pt. no. 200412)

CCD - Location

In rotating unit. To access, remove the head support, lower protective cover, the left aperture cover and then the EMC shield (see section 7.1).



CCD - Field replaceable parts

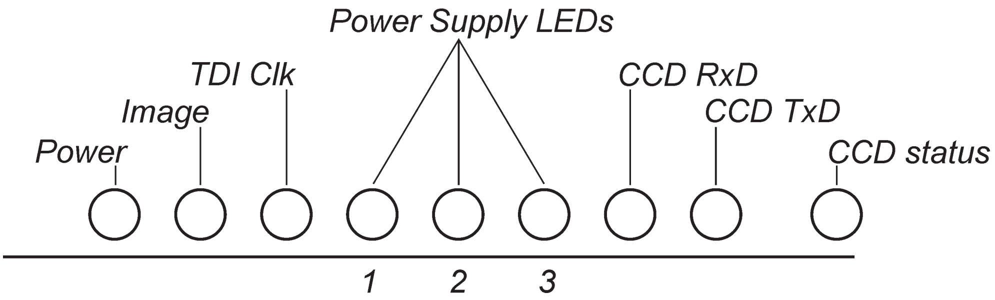
None. Inside the CCD Sensor there is the CCD Sensor board. The board cannot be accessed.

CCD - Description

CCD sensor converts X-ray radiation to visible light and and then the CCD semiconductor chips measure the intensity of the visible light. The analog signal is A/D-converted and sent in parallel data lines to the CPU board.

CCD - Indicator lights

Remove the covers from the CCD side of the rotating unit On the rear of the CCD sensor there are a number of LEDs that indicate the status of the CCD sensor.



LED	Colour	Indicates
Power	Yellow	Indicates that the power signal is active.
Image	Yellow	Indicates image signal activity. It tells the CCD sensor A/D-converter to sample image data according to the TDI frequency.
TDI Clk	Yellow	Indicates that the clocking frequency of the CCD is available.
	Off	TDI frequency is between 0...50Hz.
	On	TDI frequency is between 100 Hz...1kHz.
	Flashing	TDI frequency is between 50...100Hz or above 1kHz.
Power Supply		Indicate the different voltages required by the CCD sensor. The microcontroller in the CCD sensor monitors the voltages and activates the LEDs accordingly. There are software set limits for the various supply voltages. The LEDs come on during image capture.
1	Yellow	+3.3V and +1.8V LEDs Supply voltages for the CCD clock controlling FPGA. The +3.3V is generated in L200 from +8V_ANA. The +1.8V step down is generated in CCD sensor
board		from +3.3V. LIMITS: +3.3V between +3.0 and +3.6V. +1.8V between +1.71V and +1.89V.
2	Yellow	Analog +5V LED. L200 generates this voltage from +8V_ANA. Supply voltage for AD-converters. LIMITS: between +4.5V and +5.5V

3	Yellow	+15V, +3V and –9V LED L200 generates: +15V from +24V +3V from +8V_ANA -9V from the DC voltage of the 9VAC rectifier bridge CCD gate voltages LIMITS: +15V between +13.5V to +16.5V +3V between +2.4V and +3.6V -9V between -9.92V and -9.17V Another required voltage is μC +3.3V. It is used to power the microcontroller.
CCD TxD and CCD RxD	Yellow	Serial communication. In normal operation they flash intermittently. They indicate communication activity. If CCD RxD is off (passive CCD sensor), CCD TxD will also be off. NOTE: If CCD TxD is off, CCD RxD is on and the CCD status LED flashes during and after image capture it indicates that the CCD sensor tried to receive the image, but the transmit communication routine failed.
CCD Status	3-color	It indicates that the CCD is connected, all the software has been downloaded and it is ready to take an image.
	Green	Stand-by mode.
	Yellow	Image capture mode (power on).
	Red	In position but not yet ready, SW is being loaded.
	Red flashing	Fatal SW error / communication routine failure after an image has been taken. If this happens, switch the unit off for 10 seconds and then switch the unit on again.

4. Troubleshooting

4.1 Initial checks

Restarting the unit

If the unit fails to operate, fails to operate correctly or if an error code appears, switch the unit off, wait for a few seconds and then switch the unit on again. If the unit still does not operate correctly or the error message reappears, follow the troubleshooting procedures described here to correct the problem.

If there is a problem with image transfer, close and reopen the dental imaging software and/or restart the PC.

Error Codes

If the unit malfunctions or if it is used incorrectly an error code will appear on the main control panel.
There are two categories of error code:

- **H**, user errors, and
- **E**, system errors.

When an error code appears on the display the unit will stop working. The unit cannot be operated while the error code is on the display.
To clear an error code from the display, correct the error and then press any key on the main control panel (NOT the side control panel).
NOTE:
Error E18, L600 (Control panel) failure can only be seen on the service assistant.

Checking circuit boards

Circuit boards cannot be repaired in the field. On some boards some fuses can be replaced. But, if a board is faulty, replace it.

On most of the circuit boards there are indicator LEDs, that allow the operation of the board to be monitored, and test pins (TP), that allow the operation of the board to be checked. LED and test pin descriptions for each circuit board are in the section 3 Circuit Boards.
Use a digital multimeter (DMM) when checking boards.

Checking cables and connectors

Visually check cables for mechanical damage, cuts, damaged insulation and twists. If a cable is damaged in any way replace it.

If there is no obvious mechanical damage to a cable but you think that it may be faulty, use a digital multimeter (DMM) to check the resistance of the different wires within the cable. An undamaged wire will have close to no resistance (>0 ohm), a damaged wire will have a high resistance value.

Make sure that all cables are correctly and securely attached to their respective connectors. Connectors must not be loose or misaligned. If the connector has a locking mechanism make sure that it is locked.

If you find a loose or misaligned connector, disconnect it and check for bent, broken or missing pins. If there is damage that can be easily repaired, for example straightening a bent pin, repair the damage and reconnect the connector. If the damage cannot be repaired replace the cable.
Note that if the connector on the board is also damaged, the board may also have to be replaced.

Power supply problems

Power supply problems are described in section - **4.2 Problems during start up**.

4.2 Problems during start up

Nothing happens when the unit is switched on

The on/off switch light does not come on.

CAUSE A
Power cut.
SOLUTION A
Check to see if the power has been cut off.

CAUSE B
Unit not connected to the main power supply
SOLUTION B
Make sure that the unit is connected to the main power supply. Check the condition of the power supply cable. If it is damaged, replace it.

CAUSE C
The main fuses (2) have blown.
SOLUTION C
Disconnect the main power supply cable from the unit and then replace the main fuses (2). They are located below the main power supply cable at the rear of the column.
The fuse ratings are:
5A 230VAC or
8A 115VAC.
Case 5mm x 20mm, UL approved.

The on/off switch light comes on but the control panel does not light up.

CAUSE A
L600 (Control panel) is not receiving power or is faulty.
SOLUTION A
Check the supply of power to L600. Power is routed to L600 as follows:

1. Mains power, 230/115VAC, is supplied to **L100 (Z-Motor Driver**.
   If L100 is receiving power lamp LA1 (on L100) will be on.
   If it is not, check the cables and connectors between the on/off switch and L100 (J105 and J106) and replace the cables if they are faulty.
   If the cables are okay, replace L100.

2. L100 (Z-motor driver) supplies 230/115VAC to the **Generator Board**.
   Check that lamp LA1 on the Generator Board is on.
   If it is not, check the cable and connectors between L100 and the Generator board (X47) and replace the cable if it is faulty.
   If the cable is okay, replace the Generator board.

3. The Generator board supplies 230/115VAC to the **Transformer**.
   Check the cable and connectors between the Generator board (X45) and the Transformer and replace the cable if it is faulty.

4. The transformer supplies 18, 9, 8VAC to the **L200 (CCD Power supply)**.
   Check that the LEDs D1, D2 and D14 on L200 are on.
   If they are not on check fuse FH1 on the Generator Board and replace if blown.
   If the LEDs do not come on after replacing FH1, check the cable and connectors between the Transformer and L200 (J205) and replace the cable if it is faulty.
   If the cable is okay, check fuses F1, F2 and F3 on L200 (CCD Power supply) and replace if blown. If the indicator LEDs on L200 still still do not come on, replace L200.
   NOTE: If only one or two of the LEDs come on it indicates that the Transformer is faulty.

5. L200 (CCD Power supply) supplies 5VDC to **L500 (Connector board)**.
   Check the cable and connectors between L200 (J204) and L500 (J506) and replace the cable if it is faulty.
   If the cable is okay, check the power supply between TP1 (GND) and pin 8 on IC3, it should be 5VDC.
   If there is no power, replace L500.

6. L500 (Connector board) supplies 5VDC to **L600 (Control panel)**.
   Check the cable and connectors between L500 (J507) and L600 (J601) and replace the cable if it is faulty.
   If the cable is okay, replace L600.

7. If the control panel still does not work correctly, the SPI Serial Peripheral Interface bus may not be working correctly.
   Replace L400 (CPU board).

Error E 5 (Line voltage tolerance)

CAUSE
Line voltage to high or low.
SOLUTION
The error code will clear automatically when the voltage returns to its normal level.
If the voltage is not stable where the unit is being used, you may have to instal a voltage stabilizer.
Check that LEDs D1, D2 and D14 on L200 are on.
If some of the LEDs do not come on check the fuses on L200. Replace any faulty fuses.

Error E 16 (Exposure switch or control panel)

CAUSE A
Exposure switch or control panel key(s) not working.
SOLUTION A
Switch the unit off and then on again.
If the error code reappears replace the control panel.

CAUSE B
Exposure switch stuck down during unit start.
SOLUTION B
Release the exposure switch so that it is not stuck in the exposure position. If the error code reappears replace the exposure switch.

Error E 20 (Flash check error)

CAUSE
The check sum test failed on the flash memory.
SOLUTION
Replace L400.

4.3 Problems while preparing the unit for an exposure

None of the control panel indicator nor alphanumeric LEDs come on (Error E 18 on service assistant)

CAUSE A
L600 (Control panel) is not connected to L500 (Connector board) or L600 has failed
NOTE:
Check the service assistant to see if error code E 18 appears. If it does, it indicates either that the cable between L600 and L500 has been disconnected or is damaged or that L600 is faulty.

SOLUTION A
Reconnect or replace the cable that connects L600 (J601) and L500 (J507).
If the control panel LEDs do not come on, replace L600.

The control panel indicator and alphanumeric LEDs do not come on when they should

CAUSE A
L600 (Control panel) is faulty
SOLUTION A
Replace L600.

The control panel Return key does not work

CAUSE A
The emergency switch has been pressed down.
NOTE: LED D4 (ESTOP on) on L100 will come on when the emergency switch is pressed down.
SOLUTION A
Turn the emergency switch clockwise to release it.

CAUSE B
The Membrane key panel (side or main) is faulty.
SOLUTION B
Press some of the other keys to see if they work correctly. If they do it indicates that the return membrane key is faulty and the membrane key panel must be replaced.

Error E 7 (Positioning error)

CAUSE
N2500 or L300 or rotating unit stepper motor is faulty.
The rotating unit cannot position itself correctly and keeps on rotating, until the timeout (E 9) stops movement, because N2500 is faulty.
The rotating unit does not move when the R key is pressed.
SOLUTION
N2500 can be checked by using the service command "optotest", see section **Service Assistant and Service Functions**.
The **optotest** command displays values that indicate the position of N2500. When you manually rotate the rotating unit the values should change, sector 0, sector 1, sector 2 and sector 3, which indicates that the optosensors on the board are working and that N2500 is functioning correctly.
If the values do not change, N2500 or the cable from L500 to N2500 is defective.
If N2500 is functioning correctly it indicates that there is a problem with the stepper motor.
Check LEDs DI and D2 on N300. If they are on the stepper motor or cable from N300 to the stepper motor is faulty.

Error E 9 (Rotating motor timeout)

CAUSE
The rotating motor automatically stops operating after 30 seconds.
SOLUTION
Refer to the information in Error E 7 (Positioning error)

Rotating unit stop rotating, no error code

CAUSE A
Faulty N300 or stepper motor.
SOLUTION A
Check LEDs DI and D2 on N300. If they are on the stepper motor or cable from N300 to the stepper motor is faulty.

Patient positioning light(s) do not come on

The patient positioning lights (lasers) come on when:
- the light key is pressed
- or one of the up/down keys is pressed
- or the mirror is opened.

One of lights does not come on.

CAUSE A
The light is faulty.
SOLUTION A
Check the cable and connector from the L100 (Z-motor driver) to the light and replace the cable and light if faulty.
Realign the light, refer to the installation manual.
If the cable is okay replace the N100 (Z-motor driver).

None of the lights come on.

CAUSE A
The emergency switch has been pressed down.
NOTE: LED D4 (ESTOP on) on L100 will come on when the emergency switch is pressed down.
SOLUTION A
Turn the emergency switch clockwise to release it.

CAUSE A
N100 (Z-motor driver) is faulty.
SOLUTION B
Check that N100 (Z-motor driver) is functioning by measuring the PLENA signal (J116, pin 4), 0>5VDC.
Replace N100 (Z-motor driver) if it is not functioning correctly.
NOTE:
When LED D1, on N100 (Z-motor driver), is on it indicates that the board is receiving 5VDC from N200 (CCD power supply). If the LED D1 is not on there is a power supply problem.

CAUSE B (Unlikely)
All the lights are faulty.
SOLUTION B
Replace all the lights, they are connected to N100 (Z-motor driver) and then realign them. Refer to the installation manual.

NOTE:
If the lights come on when the mirror is opened but not when the light key or one of the up/down keys on the side control panel is pressed, then the up/down membrane switch/cable is faulty and must be replaced. Note that the lights will automatically switch off after 30 seconds.

If the lights come on when the light key or one of the up/down keys is pressed but not when the mirror is opened, the mirror microswitch/cable must be changed.

Up/down (Z-motor) keys do not work

CAUSE A
The emergency switch has been pressed down.
NOTE: LED D4 (ESTOP on) on L100 will come on when the emergency switch is pressed down.
SOLUTION A
Turn the emergency switch clockwise to release it.

CAUSE B
Z-motor not receiving power.
SOLUTION B
Check to see if lamp LA1 and LED D1 on L100 are on. If they are not then check fuse F1. Replace if blown. If after replacing fuse F1 lamp LA1 comes on but LED D1 still does not come on, replace L200.

If LA1 and D1 are on check the cable from L100 (J104) to the Z-motor. Replace if faulty.
If the cable is not faulty measure the AC voltage from the Z-motor connector, on L100, to the Z-motor. Press the UP/DOWN key and check that there is an AC-voltage.
Note that you need to connect the DMM differently when running the unit in the Up direction and in the Down direction.
If no voltage can be measured, replace the Z-motor.

CAUSE C
The side control panel (up/down keys) has failed
SOLUTION C
If D2 and D3 on L100 do not come on when the up/down keys are pressed it indictes that the side control panel or the cable from the control panel are faulty and must be replaced.

CAUSE D (Unlikely)
The Z-movement end microswitch (top or bottom has failed) and the mechanical Z-movement end stops have stopped the Z-carriage.
SOLUTION D
Check to see if D3 on L100 is on. If on it indicates that the top or bottom Z-movement end microswitch has not been activated.

Drive the vertical carriage away from the mechanical Z-movement end stops by using the SW switches on L100.
DANGER - HIGH VOLTAGE!
Take great care when pressing the switches SW1, SW2, SW3 not to touch indicator lamp LA1 which is 240 / 115VAC.
Press SW1 + SW1 simultaneously to drive the vertical carriage up and SW2 + SW3 simultaneously to drive vertical carriage down.
Replace the end microswitches.

Error E 8 (Z-motor timeout)

CAUSE
The Z-motor automatically stops operating after 30 seconds.
SOLUTION
This is a safety feature. Clear the error and check that the Z-motor operates correctly press up/down keys).
If it does not, follow the troubleshooting pricedures described in the section "Up/down (Z-motor) keys do not work".

4.4 Problems during exposure

Nothing happens when the exposure button is pressed

CAUSE A
Exposure switch locked.
SOLUTION A
Unlock exposure switch. (The lock is located at the rear of the unit next to the on/off switch).

CAUSE B
Fuse F1 on L200 has blown.
SOLUTION B
LED D2 on L100 indicates if the unit is receiving power. If the LED is not on replace fuse F1 on L200.

CAUSE C
Exposure switch failed.
SOLUTION C
Replace the exposure switch.

Error code H1 (Exposure interupted)

CAUSE A
OPERATOR ERROR. The exposure button was released during an exposure.
SOLUTION A
Advise the operator to hold down the exposure button for the duration of the exposure.

CAUSE B
The exposure button failed while it was being pressed during an exposure.
SOLUTION B
Take a test exposure to see if the same error code appears again. If it does, replace the exposure button.

Error codes E0, E1 and E2

NOTE:
Error codes E0, E1, E2 all indicate that the tubehead and/or Generator board are not functioning correctly.

E 0 (Tube arcing)
CAUSE
Tube arcing.
NOTE:
Check the tube fail LED (red) in the upper right corner of the Generator board. If it is on it indicates that the tube is arcing.
E 1 (tubehead voltage)
CAUSE
Tubehead voltage (kV) too high or too low.
E 2 (tubehead current)
CAUSE
Tubehead current (mA) too high or too low.
SOLUTION
First use the Service Assistant to check the mA and kV feedback signals from the tubehead to see if the tube voltage and current are correct (Software Check).
To do this open the Service Assistant (**Alt + Ctrl + shift + T**) and select the **exp** service function (Refere to Service Assistant and Service functions in section 5).
The values for feedback signals should be as follows:
kVfb (60kV) = 3.0 V ±0.2 V (2.8 - 3.2)
kVfb (70kV) = 3.5 V ±0.2 V (3.3 - 3.7)
mAfb (7mA) = 2.0 V ±0.2 V (1.8 - 2.2)

Select an exposure time of 2000 ms (2 seconds) or greater so that the mAfb and kVfb ADC values can be measured.

CAUTION:
Protect yourself from radiation when carrying out this procedure.
Press and hold down the exposure button. The "actual" mAfb and kVfb ADC values will appear on the display next to "target" values.
If the "actual" values differ by less that 20% from the target values, the tubehead is working correctly.

If the "actual" values differ by more than 20% from the target values, it indicates that there is a problem and the tubehead must be recalibrated.

From the Service Assistant select **calib** and calibrate the tubehead.
After recalibrating the tubehead check if the calibration was successful.

If the calibration is successful select the **exp** function again and confirm that the mA and kV feedback signals are correct.

If the calibration was unsuccessful and the unit still does not work correctly, check the hardware.

Hardware check
Remove the cables from the tubehead side of the rotating unit. Check the cables between the Tubehead and the Generator board. Replace them if they are faulty and then recalibrate (**calib**) the tubehead.

If recalibration is not sucessful, measure the feedback signals from the Generator board. From the Service Assistant select **exp**.

Connect a DMM to the TP14 (kVfb) and TP17 (GND) on the Generator board and take an expose.

Then connect the DMM to TP18 (mAfb) and TP17 (GND) and take another exposure.
The values for feedback signals should be as follows:
kVfb (60kV) = 3.0 V ±0.2 V (2.8 - 3.2)
kVfb (70kV) = 3.5 V ±0.2 V (3.3 - 3.7)
mAfb (7mA) = 2.0 V ±0.2 V (1.8 - 2.2)

If values for the feedback signals are not within the limits, and recalibration does not help, measure the reference signals from L400.

Connect a DMM to TP12 (kVref) and TP17 (GND) on L400 and take an exposure.

Then connect the DMM to TP11 (mAref) and TP17 (GND) and take another exposure.
The values for the reference signals should be as follows: (These values are only "guidelines", and depend on the unit.)
kVref (60kV) = 3.0 V ±0.2 V (2.8 - 3.2)
kVref (70kV) = 3.5 V ±0.2 V (3.3 - 3.7)
mAref (7mA) = 2.0 V ±0.2 V (1.8 - 2.2)

If the reference values are correct, but feed back values are not, the Tubehead and/or the Generator board may be faulty and must be replaced.
If there are no reference signals check the cabling between the Generator board and L500. Replace if faulty.

Error E 6 (Exposure timeout)

CAUSE A
Exposure timeout error, exposure more than 10 seconds.
SOLUTION A
If LED D6 on is not on L400 has failed. If it is replace the Generator board.

Error E 10 (CCD initialization/configuration failure)

CAUSE
There is no serial bus connection or the CCD sensor could not configure itself.
SOLUTION
Check the condition of all the cables and connectors to/from the CCD sensor as well as the cables from CPU to L500 and cables between L500 and L200. Also check that L200 functions correctly. Check that none of the fuses on L200 have blown.

Error E 11 (CCD error)

CAUSE
Supply voltages to the CCD sensor were not within tolerances during imaging.
SOLUTION
Check the condition of all the cables and connectors to/from the CCD sensor.
Check the voltages on L200 by checking the reference LEDs. If in doubt, measure the voltages from the test points. Note that the voltages are on only during exposure, so you either have to connect a jumper to J203 on L200 or use the service command "dc".

Error E 12 (CCD error)

CAUSE
The image data flow from the CCD sensor to L400 was interrupted during the exposure.
SOLUTION
Refer to the trouble shooting information given in error code E11.

Error E 13 (CCD error)

CAUSE
Problem with image capture on the CPU board (L400).
SOLUTION
Refer to the trouble shooting information given in error code E11.

4.5 Problems after exposure

Error E 4 (Tubehead temperature)

CAUSE A
The tube head has over heated.
SOLUTION A
Wait for the tubehead to cool down.
When the tubehead reaches the right temperature the error message will automatically disappear. Note that this could take over 45 minutes.
Note that you will not be able to clear the error message until the tube head has cooled to the correct temperature. If the error message appears even if the unit has not been used a lot, switch the unit off and then on again.

CAUSE B
The tube heat signal is missing.
SOLUTION B
If the error message never clears check the path of the tube heat signal. The tubehead and/or the generator board may be faulty and must be replaced.

Vertical white stripes on the image

Probably due to tube arcing.
Refer to the trouble shooting information given in error code E0.

Horizontal white stripes on the image

Recalibrate the CCD.

1. Open the DFW program if it is not already open.

2. From the **Options** drop down menu select **Cranex Novus setup**.

3. The **CRANEX Novus Setup** window will open. Select the **Device** page.

   In the **Image Scanning** field click the **Calibrate** radio button to activate it.

4. Tape the calibration filter to the filtration label that is attached to the tubehead cover.
   The filter should be positioned vertically in the center of the filtration label.

5. Select the Adult Pan exposure program, Push the nasion support up as far as it will go and remove the chin support.

6. Protect yourself from radiation, and take an exposure.
   The image should be free of any horizontal lines/ stripes. If it is not repeat the procedure.

4.6 Bad quality images

Bad quality images can be due to one or more of the following:

- incorrect patient positioning
- a badly aligned unit
- the CCD sensor is not calibrated

Incorrect patient positioning

If the unit is producing bad quality images, first make sure that the user is positioning the patients correctly. For information on how to position the patient refer to the User's Manual.

A badly aligned unit

If patient positioning is correct, check the alignment of the unit.
For information on how to align the unit refer to the Installation and set-up manual.

The CCD sensor

Calibrate the CCD sensor. Refer to the Installation and set-up manual.

5. Service Assistant and service functions

5.1 Using the Service assistant

The Service Assistant Utility includes a number of functions that allow the unit to be tested and configured during installation, set up and service.
Note that software cannot be downloaded using the service assistant.

To open the Cranex Service Assistant:

1. Switch the unit and PC on and then open Digora for Windows or the dental imaging software you are using.

2. Press **Alt + Ctrl + Shift + T** to open the Digora Service Assistant.
   A warning will appear, click **OK**.
   The **Digora Service Assistant** window will appear.

3. In the field at the bottom of the **Digora Service Assistant** window key in **s** (case sensitive).

   ```
   >s
   ```

   Press the **Enter** key. The **Cranex Novus service terminal** will appear.

4. In the field at the bottom of the **Cranex Novus service terminal** key in **help** or **h** (lower case).

   ```
   >help (or h)
   ```

A list of functions will appear.

```
--------------------------------------------------------------------------------
CMD        DESCRIPTION (* available also in normal mode)
calib      calibrates generator references and preheat
conf       display summary of configuration data
confccd    display summary of CCD configuration data
dap        set dose area product [<value>]
dapshow    setting to show the DAP after exposure or not (1/2)
dc         takes dark current image
endu       endurance test, drives rotating unit 75 rounds
exp        exposure (<time>) in milliseconds, default is 1000
expcnt     exposure counter, use [<clear>] option to clear it
help       display info on command ('help [cmd]' or 'h [cmd]')
ip         configure ip address
kv         set default kV [<60> <70>]
log        service log [<all> <clear> <newest> <statistics>]
logsign    make a service signature for current events
mac        print mac address
optotest   prints optosensor values for 30 seconds
patt       generates test pattern from CCD module
prog       set default program [<pan> <ped> <tmj> <test>]
           (and overrides kV and set it back to default)
quit       quit service terminal
reset      software reset
restore    restore factory configuration
restgen    restore generator default values
serno      configure serial number (and MAC accordingly)
status     retrieves status and updates clock*
still      still image exposure
warmup     tubehead warmup before first use
--------------------------------------------------------------------------------
```

```
>
```

5. To select a function key in the function name, for example **exp**, into the field at the bottom of the **Cranex Novus service terminal**.

```
>exp
```

Press **Enter**.
Information about the selected function will appear at the bottom of the list of functions.

If a value can be changed or a option selected, key in the new value or select the new option, and then press **Enter** again.
If the function performs some other task, follow the instructions given.

6. To exit the **Cranex Novus service terminal**, key in **quit**.

```
quit
```

Then press **Enter**.

5.2 The Service comands

COMMAND	DESCRIPTION
calib	**calibrates generator references and preheat**

Calibrates the voltage (60 and 70 kV), current (7 mA) and prehear (mApreh) reference values for the tube head and generator board.

This calibration procedure must be carried out when the unit is installed and whenever the tube head and/or generator board are replaced.

CAUTION:
Protect yourself from radiation when carrying out this procedure.
Press and hold down the expossure button for the duration of the procedure, which will last up to three minutes. During the calibration procedure you will hear the exposure warning signal and calibration values, current at the start and calibrated at the end, will appear on the display.
When the calibration procedure is successful completed the message,
CALIBRATION WAS SUCCESSFUL
will appear.

Exit (quit) the service assistant.

NOTE:
If the calibration procedure is not successful the message,
!!!!! Calibration was NOT successful !!!!!
will appear.

If this happens, reset the generator, refer to the **restgen** service command for information on how to do this, and then repeat the calibration **(calib)** procedure.
If the calibration procedure is still not successful after the second try, the tube head and/or generator board must be changed.

NOTE:
The calibration values that appear at the start and the end of the calibration procedure should be approximately the same. They should be approximately:
MA_7_REF = 213 (±25%)
KV_60_REF = 182 (±25%)
KV_70_REF = 205 (±25%)
MA_PREH = 80 (±25%)

conf **display summary of configuration data**

Displays all the current configuration parameters of the unit. The figures in brackets (1) are factory settings.
If you wish to restore the factory settings use the **restore** command.

NOTE:
default program 1 = adult pan, 2 = child pan, 3 = TMJ and 5 = Test.

confccd **display summary of CCD configuration data**

Displays the factory and current configuration parameters of the CCD sensor. These values are for information only.

dap **set dose area product [<value>]**

Displays the dose area product (DAP) value.

dapshow **setting to show the DAP after exposure or not (1/2)**

Allows the DAP value to be set so that it will either appear or not appear on the display after an exposure.
<1> (default) DAP value will appear
<2> DAP value will not appear.

dc **takes dark current image (dc = dark current)**

Is used to check if the CCD sensor (camera) is working. Press the "Return" key to start the check.
During the check a series of values will appear in the service assistant window.
When the check is complete the text:
- CAMERA stop
will appear and then an image.
When the sensor is working correctly the vertical centre of the image will be slightly gray because of noise.

NOTE:
If an image does not appear, then the CCD sensor is faulty.

endu **endurance test, drives rotating unit 75 rounds**

Automatically drives the rotating unit through 75 rotation cycles. No radiation in generated during rotation.
This command is used during factory testing.

exp **exposure (<time>) in milliseconds, default is 1000**

Generates x-rays. The CCD sensor is not activated and the the rotating unit does not move.
It is used to check the beam alignment during unit installation (refer to the Installation manual for more information), and to trouble shoot the tubehead and generator board.

CAUTION:
Protect yourself from radiation when using this function.
The default exposure time is 1000 ms (when "exp" is keyed in). If you wish to have a longer exposure time key in "exp" and them enter a value, for example:

```
>exp 3000
```

will result is a exposure time of 3000 ms. The minimum value you can key in is 100 ms and the maximum is 10000.

Press and hold down the exposure button to activate x-rays.

If exposure times of 1000 ms or more are used, the mAfb and kVfb ADC values will appear.

To exit the command key in **q** and then press **Enter** or press the **RETURN** key on the unit control panel.

NOTE:
The kV value used for the exposure will be the one selected before entering the service mode. The kV value cannot be changed while the unit is in the service mode. If you wish to change the kV, you must exit the service mode.

NOTE:
The "**still**" command, described later, generates x-rays and activates the CCD sensor but the rotating unit does not move.

expcnt **exposure counter, use [<clear>] option to clear it**

Displays the total number of exposures taken with the tubehead.

To zero the exposure counter enter clear,

```
>expcnt clear
```

and then press **Enter**.

NOTE:
Always zero the exposure counter when the tubehead is replaced.

help **display info on command (‘help [cmd]’ or ‘h [cmd]’)**

Displays the service command list and information about the commands.

ip **configure ip address**

Displays the current IP address of the unit.

To change the IP address enter the new one,

```
> ip aaa.bbb.ccc.ddd (the new IP address)
```

and then press **Enter**.

After changing the IP address of the unit, communication between the unit and the PC will be lost and the link to the PC will have to be reconfigured. Refer to section, **3.5 Configuring the communication link to the PC**, in the installation manual.

NOTE:
The IP address can also be reset using the driver tools

kv **set default kV [<60> <70>]**

Allows the kV value that is automatically selected when the unit is switched on to be changed. There are two settings, 70 kV (the factory setting) and 60 kV.

To change the kV value, enter the new one (60),

```
> kv 60
```

and then press **Enter**.

log **service log [<all> <clear> <newest> <statistics>]**

Displays exposure logs.
There are several log options:
<all> = (default) display the complete log
<clear> erase all log entries
<newest> display the latest log entry
<statistics> display the log statistics.

To select one of the log options enter the required command,

```
> log clear
```

and then press **Enter**.

logsign **make a service signature for current events**

Allows a short note to be added to a log entry.

Add the note,

> > logsign *Note ......*

and then press **Enter**. The note will appear in the log.

mac **print mac address**

Displays the current MAC address of the unit.

To change the MAC address enter the new one,

> > mac *aa.bb.cc.dd.ee.ff (the new MAC address)*

and then press **Enter**.

After changing the MAC address of the unit, communication between the unit and the PC will be lost and the link to the PC will have to be reconfigured. Refer to section, **3.5 Configuring the communication link to the PC**, in the installation manual.

NOTE:
DO NOT change the MAC address unless you know what you are doing. The MAC address is dependent on the serial number and is set at the factory.

optotest **prints optosensor values for 30 seconds**

Allows N2500 to be checked. Optosensors on N2500 monitor the position of the rotating unit.

The "optotest" command displays, for 30 seconds, values that indicate the position of N2500. When you manually rotate the rotating unit the values should change,

```
sector 0
sector 1
sector 2
sector 3
```

which indicates that the optosensors on N2500 are working and that the board is functioning correctly.
If the values do not change N2500 or the cabling is defective.

patt **generates test pattern from CCD module**

Produces a test pattern image from the CCD.



The pattern shows a number of two-tone gray vertical lines. These indicate that the data lines to the CCD sensor are working correctly.

prog **set default program [<pan> <ped> <tmj> <test>] (and overrides kV and set it back to default)**

Allows the default exposure program, the program automatically selected when the unit is switched on, to be selected.
The choices are:
<pan> = (default) panoramic program
<ped> = child (reduced width) panoramic program
<tmj> = temporomandibular joint program
<test> = the test mode.

To select a new option enter the required command,

```
> prog ped
```

and then press **Enter**.

NOTE:
The appropriate kV for the selected progam will be automatically selected.

quit **quit service terminal**
Exits and closes the service terminal.

reset **software reset**
Reboots the unit.

restore **restore factory configuration**
Restores the configuration settings to the default factory settings. You must key in **restore configuration**.

```
> restore configuration
```

restgen **restore generator default values**
Restores the original default settings of the generator. This should be used if the calibration (**calib**) command was unsuccessful.

serno **configure serial number (and MAC accordingly)**
Displays the serial number of the unit.

```
> serno V XXXX
```

and then press **Enter**.

NOTE:
The serial number can be reset when the CPU is replaced. The serial number can only be set once.

status **retrieves status and updates clock***
For factory use only.

still **still image exposure**

Generates x-rays and activates the CCD sensor but the the rotating unit does not move.
It is used to check the beam alignment during unit installation (refer to the Installation manual for more information).

CAUTION:
Protect yourself from radiation when carrying out this procedure.

Press and hold the exposure switch to take a still image exposure.

NOTE:
The "**exp**" command, described earlier, generates x-rays but does not activate the sensor or move the rotating unit.

warmup **tubehead warmup before first use**

Initializes the tubehead. Must be used when the unit is installed or if the unit has not been used for a long time.

CAUTION:
Protect yourself from radiation when carrying out this procedure.

Press and hold the exposure switch until the procedure is complete. The procedure may take some minutes.

6. Updating the unit firmware and the core

6.1 The unit firmware

Whenever a new version of the unit firmware is released, Soredex Technical Support will make this information necessary and supply the necessary files.

The firmware in the unit can only be updated using the Soredex Service Teminal (s2terminal program). (The firmware cannot be updated using the DfW Service Assistant!).

1. Create a new folder in the PC connected to the unit. Make sure that Digora for Windows or the dental imaging program being used is closed, and then copy the new firmware and s2terminal files into the new folder.

   The firmware file is:
   novus.srec

   and the s2terminal files, required to transfere the files to the unit, are:
   s2terminal.exe (Version 1.1 or later).

   s2.dll (Version 1.1 or later).

   W32N50.dll

2. From Windows Select: **Start** / **Run**, and then type into the “Open” -field: **<cmd>** and click **OK**. The Command Prompt window will appear.

3. Go to the folder where the new firmware and s2terminal files are located.
   (Type **<s2terminal>** into the command prompt to see the instructions for the command syntax.)

4. Start the s2terminal program using the IP address of the unit:
   Type **<s2terminal 194.9.227.251>** (starts the s2terminal for a unit with the IP 194.9.227.251) and press "Enter".

   If the IP-address is correct and the s2terminal program is able to connect to the unit, the following terminal output will appear as follows:
   C:\Novus>s2terminal 194.9.227.251
   S2Terminal v1.1 (or above)
   Software version X.XX
   Core version XX
   Serial number VXXXXXX

   Or
   Using the unit control panel press the TEST and TMJ buttons simultaneously. You have 40 seconds to complete the task.
   In the Command Prompt window type:
   <s2terminal 194.9.227.251 –c>

   Press "Enter" (this will start the s2erminal and configure the IP –address to 194.9.227.251)

   If the IP-address is correct and the s2terminal program is able to connect to the unit, the terminal output will appear as follows:
   C:\Novus>s2terminal 194.9.227.251
   S2Terminal v1.1 (or above)
   Configuring scanners...done.
   Login fail (no connection)
   Login fail (no connection)

   NOTE:
   It is normal for the “**Login fail** ...” message to appear several times.

   Software version X.XX
   Core version XX
   Serial number VXXXXXX

5. Type **<xh>** into the command prompt and press "Enter" to see the instructions for the command syntax.

6. Type **<xs>** and press "Enter" to start upgrading the firmware.

7. When the upgrade is successful, the following output will appear:
   xs
   Transferring program...
   Waiting for flashing........
   Status command transfer error.
   Login fail (no connection).
   Login fail (no connection).
   NOTE:
   It is normal for the “Login fail ...” message to appear several times.

   Software version X.XXX
   Core version XX
   Serial number VXXXXXX

8. Type **<s>** and press "Enter" and the unit will enter the service mode.The following information will be seen:

   Novus vX.XXX>s
   Where v.X.XXX is the new firmware version!

   Cranex Novus service terminal

   Service>

9. Enter **<help>** and press "Enter" to display the valid commands.

10. Enter **<quit>** and press "Enter" to exit the service mode.

11. Enter **<xq>** and press "Enter" to quit the s2terminal program.

12. Restart the unit to make sure that it functions correctly.

6.2 Updating the core

It is not necessary to systematically upgrade the core in all Novus units, unless Soredex Technical Service requests it.

Core upgrading is done using s2terminal -program (Core cannot be updated with the DfW Service Assistant!).

1. Make sure that Digora for Windows or the dental imaging program being used is closed. Copy the core file to the same dedicated folder as the s2terminal files.

2. Start the s2terminal program using the IP address of the unit:
   Type **<s2terminal 194.9.227.251>** (starts the s2terminal for a unit with the IP 194.9.227.251).

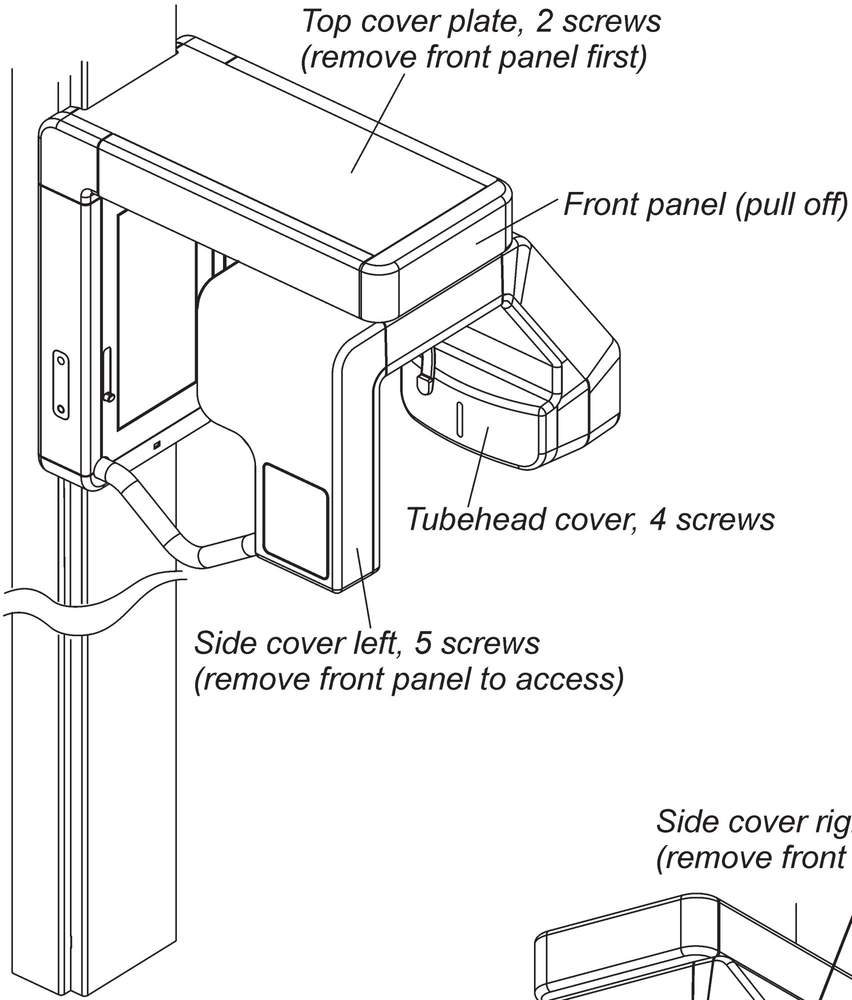
3. Enter **<xh>** and press "Enter" to display the help menu.

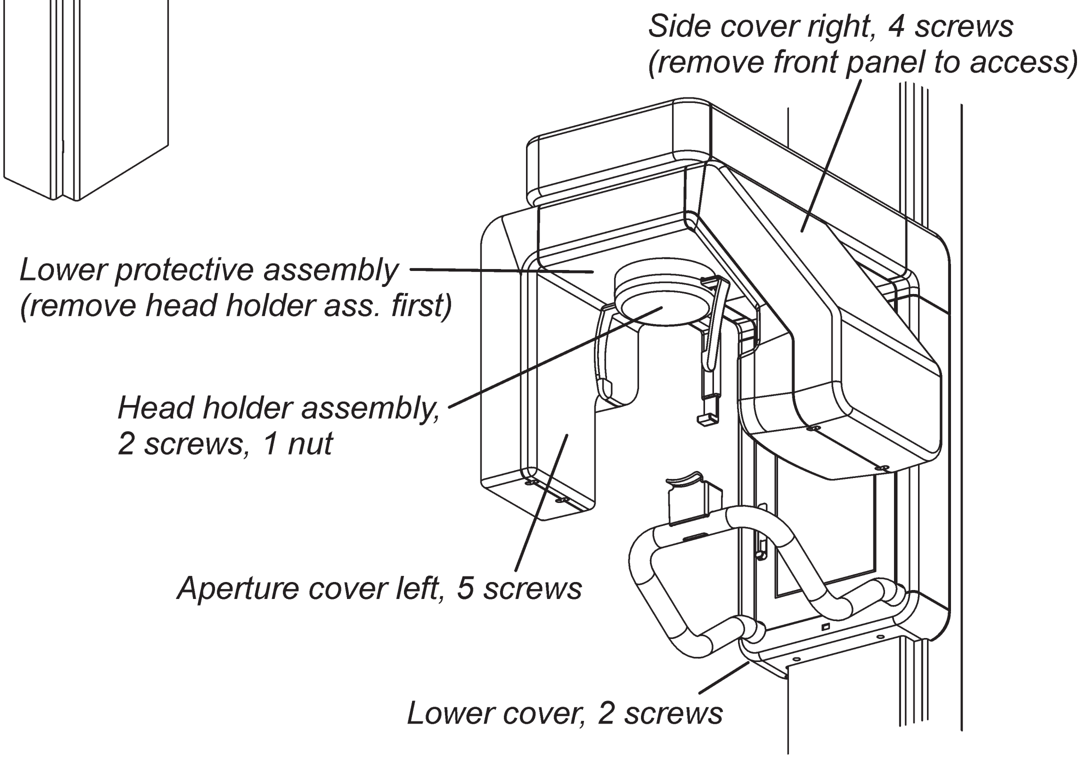
4. Enter **<xcXX>** (where XX is the version number in the core filename) and press "Enter" to start the firmware upgrade.
   For example: if the core filename is novuscore26.pof, the command will be <xc26>.

5. Restart the unit to make sure that it functions correctly. and check that the “Core version XX” – output has changed to the new version (the new core automatiaclly loads at startup).

7. Replacing parts.

7.1 Removing covers





7.2 Replacing the tubehead

Tools required

The normal installation and alignment tools.

Replacement parts

- New tubehead
- Tubehead label
- Screw locking plates (2)

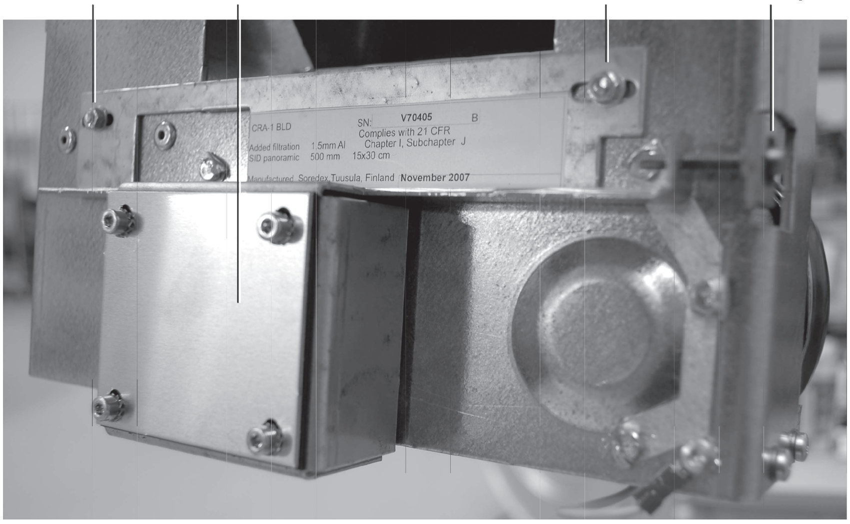
Replacing the tubehead

1. Switch the unit off and disconnect it from the main power supply.

2. Remove the *tubehead cover* and the *side cover right* from the tubehead side of the rotating unit.

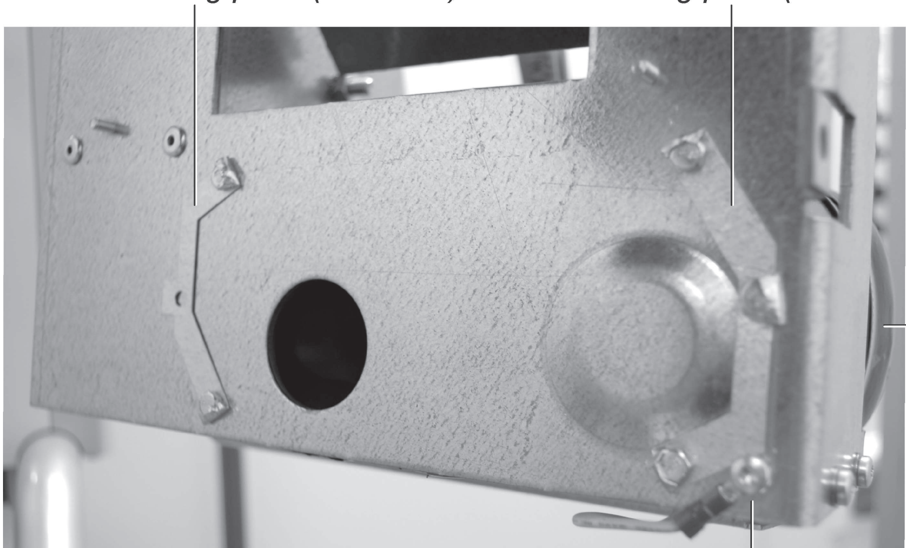


3. Remove the circlip from collimator adjusting screw and then remove the nuts (2) that hold the collimator in position.
   Remove the collimator from the rotating unit.



4. Disconnect all cables and the ground cable from the tubehead.

5. Straighten the screw locking plates and remove the (5) screws that hold the tube head to the rotating unit and the remove the tubehead.



6. Attach the new tubehead to the rotating unit.

7. Secure it in position with the new locking plates and screws.
   CAUTION:
   Tighten the screws to a maximum torque of 0.5 Nm.

8. Bend the ends of the locking plates up to prevent the screws from loosening.

9. Reconnect all the cables.

10. Reattach the collimator but do but do not tighten the nuts until you have checked the alignment of the tube head.

11. Replace the circlip.

Calibrating the tube head and checking the alignment

1. Reconnect the unit to the power supply and then switch the unit on.

2. Open the service assistant.
   Carry out the “warmup” procedure and then “calib” procedure.
   Also set the exposure counter to zero (“expcnt clear”).

3. Align the unit (refer to the installation manual for information on how to do this).

4. Open the Novus setup page in DfW. Choose the calibration mode and take the calibration image (use the calibration filter supplied with the unit).

5. Replace all the covers.

6. Attach the new tubehead label to the underside of the tubehead side of the rotating unit.



New tubehead label (underside of the tubehead side of the rotating unit)

IMPORTANT NOTE:
Please return the tubehead to the Soredex for examination.

Appendix A. Technical Information

A.1 Technical specifications

Type

CRA-1

Classification

Complies with IEC 60601-1/1995, IEC 60601-2-7/1998, IEC 60601-2-28/1993 and IEC 60601-2-32/1994, IEC 878, UL 2601-11/2006 (for products with the UL Classification Mark) and EN 55011 standards
Conforms with the regulations of DHHS Radiation Performance Standard, 21CFR Subchapter J.
Safety according to IEC 60601-1
Protection against electric shock - Class 1
Degree of protection - Type B applied with no conductive connection to the patient
Protection against the ingress of liquids - IPX 0
Disinfection methods:

- mild soapy water (non-abrasive)
- non-alcohol based disinfectant for the the chin rest
- disposable plastic covers for bite piece, chin rest and lip support

For use in environments where no flammable anaesthetics nor flammable cleaning agents are present
Mode of operation - continuous operation/intermittent loading

Unit description

A dental panoramic x-ray units with a high frequency switching mode x-ray generator. The unit takes panoramic exposures.
The unit uses a CCD sensor as an image receptor.

Generator

TUBE

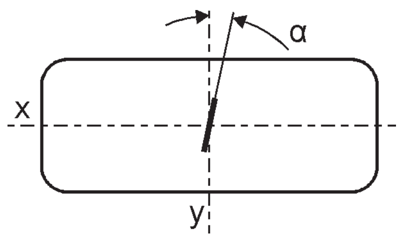
- KL40-0.5-70, D-058 or OX/90

FOCAL SPOT

- 0.5 mm (IEC 60336/1993)

TARGET ANGLE

Tube	α
KL40-0.5-70	12°
D-058	12,5°
OX/90	19°



TARGET MATERIAL

- Tungsten

OPERATING TUBE POTENTIAL
- Panoramic imaging 60 and 70 kV (±5 kV)

OPERATING TUBE CURRENT
- 7 mA (±1 mA)

NOMINAL ANODE INPUT POWER
- 490 W nominal at 70 kV, 7 mA

MAXIMUM TUBE CURRENT
- 7 mA

MAXIMUM ANODE OUTPUT POWER
- 600 W nominal nominal at 75 kV, 8 mA, 0.1 s

REFERENCE TIME PRODUCT
- 7 mAs at 60 kV, 7 mA, 1.0 s

FILTRATION
- inherent filtration minimum 0.8 mm Al at 50 kV (IEC 60522/1999)
- additional filtration 1.5 mm Al
- patient support attenuation equivalent less than 0.2 mm Al
- total fltration 2.5 mm Al at 70 kV

BEAM QUALITY
- HVL over 2.0 mm Al at 70 kV

PRIMARY PROTECTIVE SHIELDING
- minimum 0.5 mm Pb or equivalent

OUTER SHELL TEMPERATURE
- +50ºC (122ºF) maximum

DUTY CYCLE
- controlled by the software of the unit

Power requirements

INPUT VOLTAGE
- 115/230 VAC (±10%), 50/60 Hz single phase, grounded socket

LINE CURRENT

115 VAC
- long term: 1.6 A (cont) at 70 kV/7 mA, 115 VAC mains)
- momentary: 8 A at 70 kV/7 mA, 115 VAC mains)

230 VAC
- long term: 1 A (cont) at 70 kV/7 mA, 230 VAC mains)
- momentary: 5 A at 70 kV/7 mA, 230 VAC mains)

MAXIMUM LINE RESISTANCE
- 1 ohm

MAXIMUM LINE FUSING
- 10 A /16A slow at 230/115 VAC (main fuse 5 A/8 A slow in the device)

LINE SAFETY SWITCH (when required)
- Approved type, min. 10 A 250 VAC

EARTH LEAKAGE CIRCUIT BREAKER (when required)
- Approved type, min. 16 A 250 VAC, breaker activation leakage current in accordance with local regulations.

Mechanical parameters

PANORAMIC
- Source to Image layer Distance (SID) 500 mm (±10 mm)
- Magnification factor 1.25

WEIGHT
- 100 kg

DIMENSIONS
- (H x W x D) 2316 x 835 x 1070 mm

VERTICAL HEIGHT OF CHIN REST
- 950 - 1750 mm (± 10 mm)

Digital image receptor (CCD)

PIXEL SIZE
- 96 microns

ACTIVE SENSOR SURFACE
- 147.5 x 6.1mm

Timer

EXPOSURE TIMES
- Normal 9.0 s (±15%)
- Child 7.5 s (±15%)
- TMJ 1.8 + 1.8 s (±15%)

SINGLE LOAD RATING

70 kV, 7 mA, 9 s, panoramic

BACK-UP TIMER
- 12 s (±15%)

Leakage technique factors

PANORAMIC
- 70 kV, 1200 mAs/h (70 kV, 7 mA, duty cycle 1:20, for example a normal exposure per 3 minutes cool-down period)

Measurement bases

The kV is measured by monitoring differentially the current flowing through 450 Mohm, 1% feedback resistor connected between the tube anode and ground. The mA is measured by monitoring current in the HT return line, which equals the tube current.

Collimator

PRIMARY SLIT

- Adult panoramic slit only. For child panoramic the exposure time is reduced to give a reduced length image.

PRIMARY SLIT SIZE

- 0.7-0.75 x 38 mm

Z-motor

DUTY-CYCLE

-Intermediate use: 6.25%, 25s ON, 400s OFF

Environmental data

OPERATING

- Ambient temperature from +10ºC to +40ºC
- Relative humidity 10 - 90%, no condensation

STORAGE/TRANSPORTATION

- Ambient temperature from -20ºC to +50ºC
- Relative humidity 5 - 85% no condensation
- Atmospheric pressure 500 - 1080 mbar

PC requirements

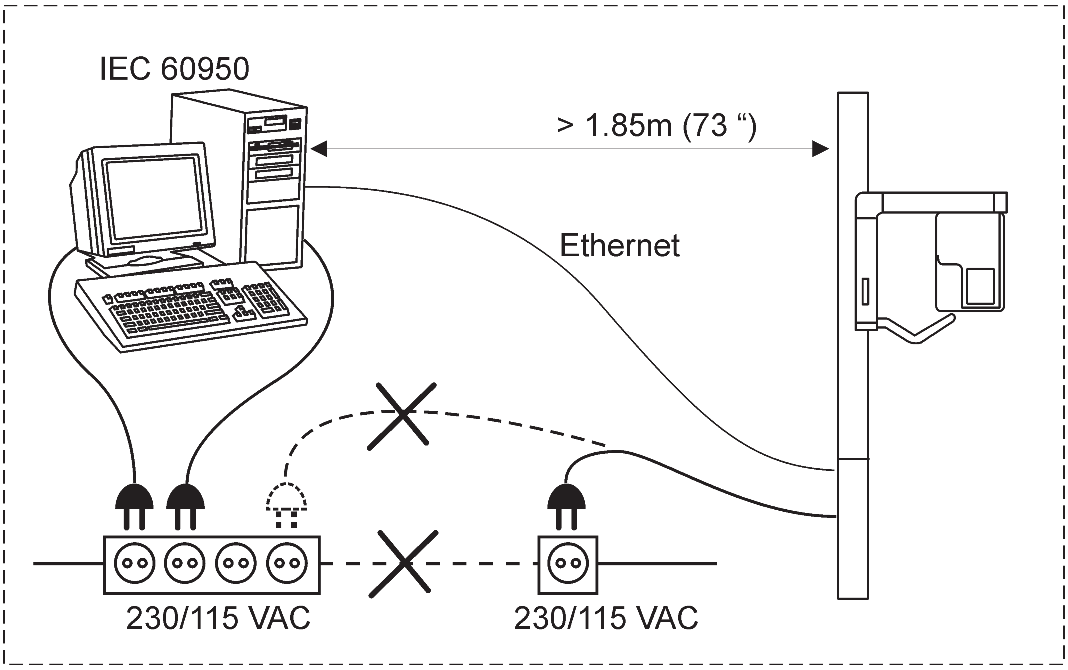
- The PC must meet the IEC 60950 standard (minimum requirements).
- Windows XP Professional, SP1 or SP2 or Windows 2000 Professional SP4
- 512 MB RAM, >20 GB HDD
- 32 MB Video RAM
- Pentium 4 or equivalent
- One Ethernet 10/100 Mbit/s NIC
- 19” CRT or 17” TFT LCD (min. resolution 1024 x 768 pixels with DfW)

System requirements and connections

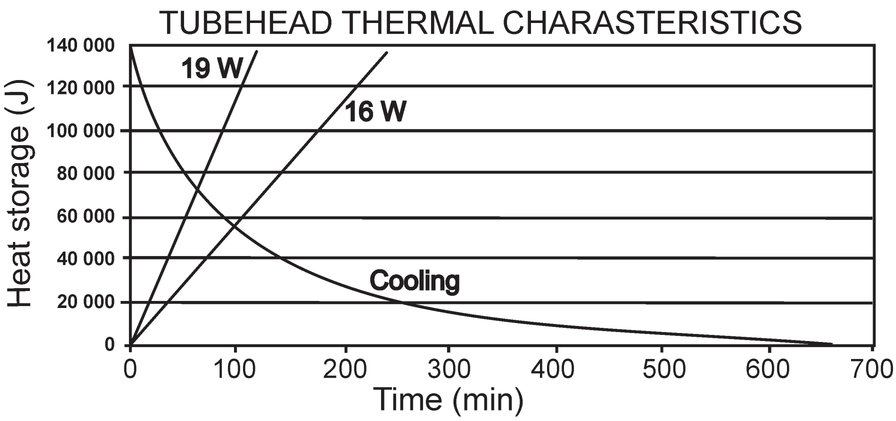
- The PC and any other external device(s) connected to the system must meet the IEC 60950 standard (minimum requirements).
Devices that do not meet the IEC 60950 standard must not be connected to the system as they may pose a threat to operational safety.
- The PC and any other external devices must be connected in accordance with IEC 60601-1-1.
- The x-ray unit must be connected to it’s own separate power supply. The PC and any other external devices must NOT be connected to the same power supply as the x-ray unit.

- Position the PC and any other external device at least 1.5 m (60”) from the x-ray unit so that the patient cannot touch the PC or any other external device while being x-rayed.
- The PC and any other external devices shall not be connected to an extension cable.
- Multiple extension cables shall not be used.
- Do not position the PC where it could be splashed with liquids.
- Clean the PC in accordance with the manufacturer’s instructions.

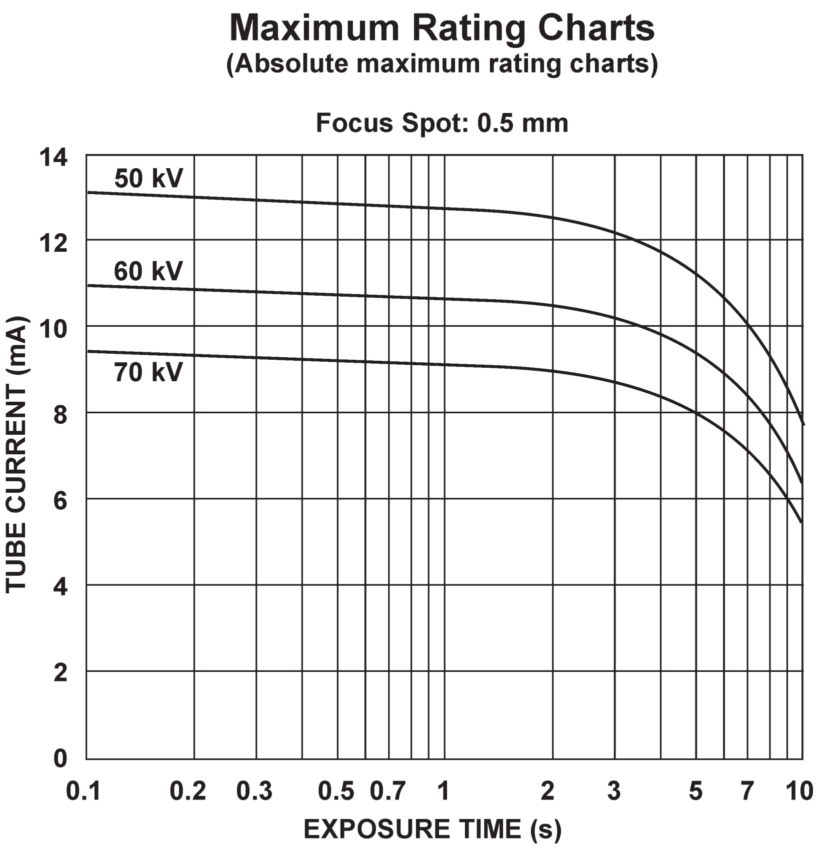
X-ray system - to IEC 60601-1-1



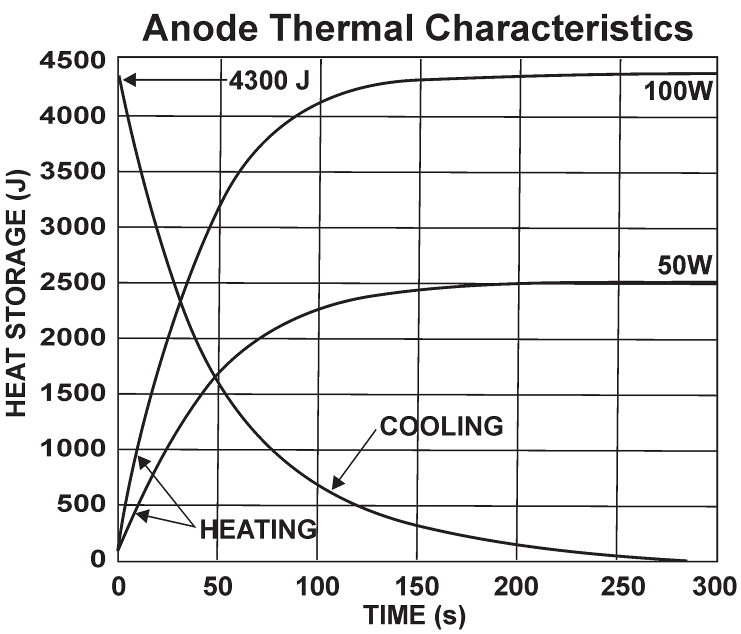
Tube housing assembly cooling/heating characteristics



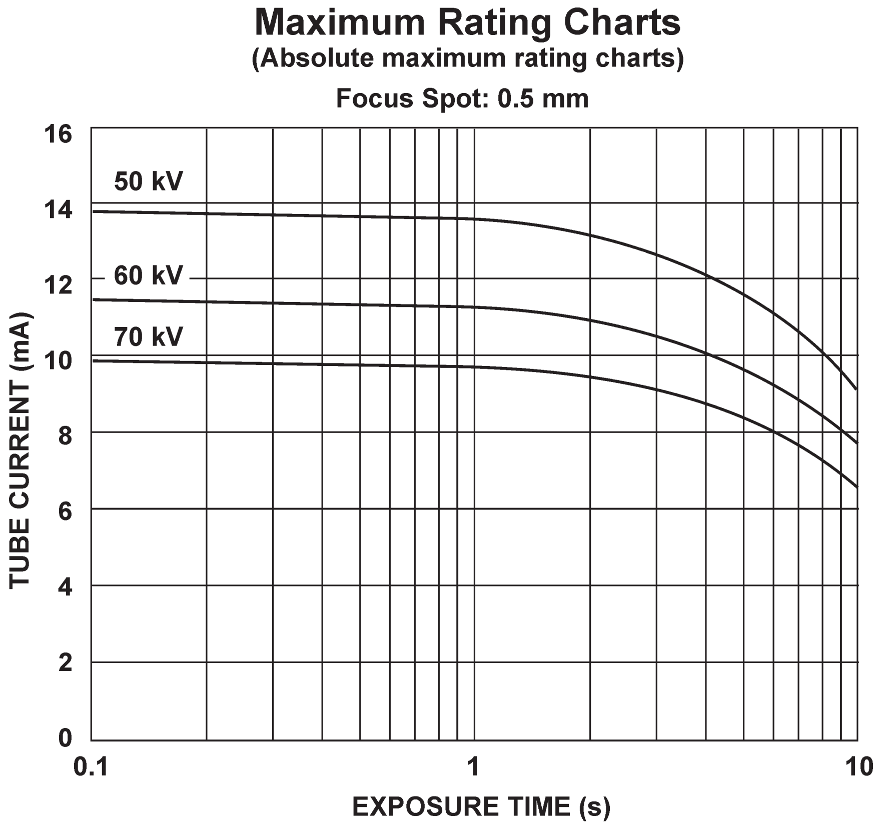
Tube rating chart KL40-0.5-70



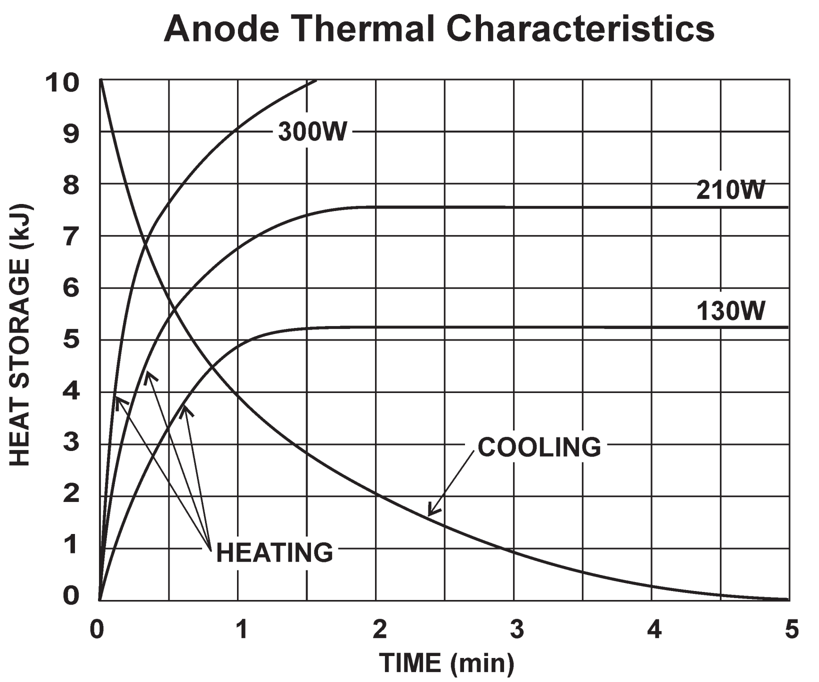
Anode thermal characteristics



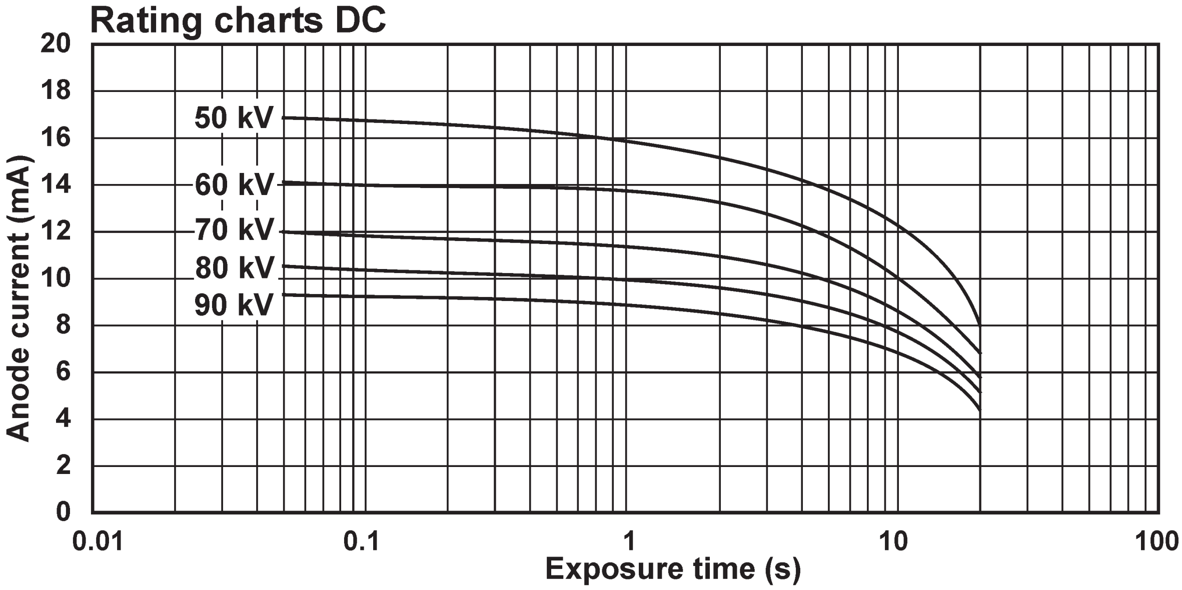
Tube rating chart D-058



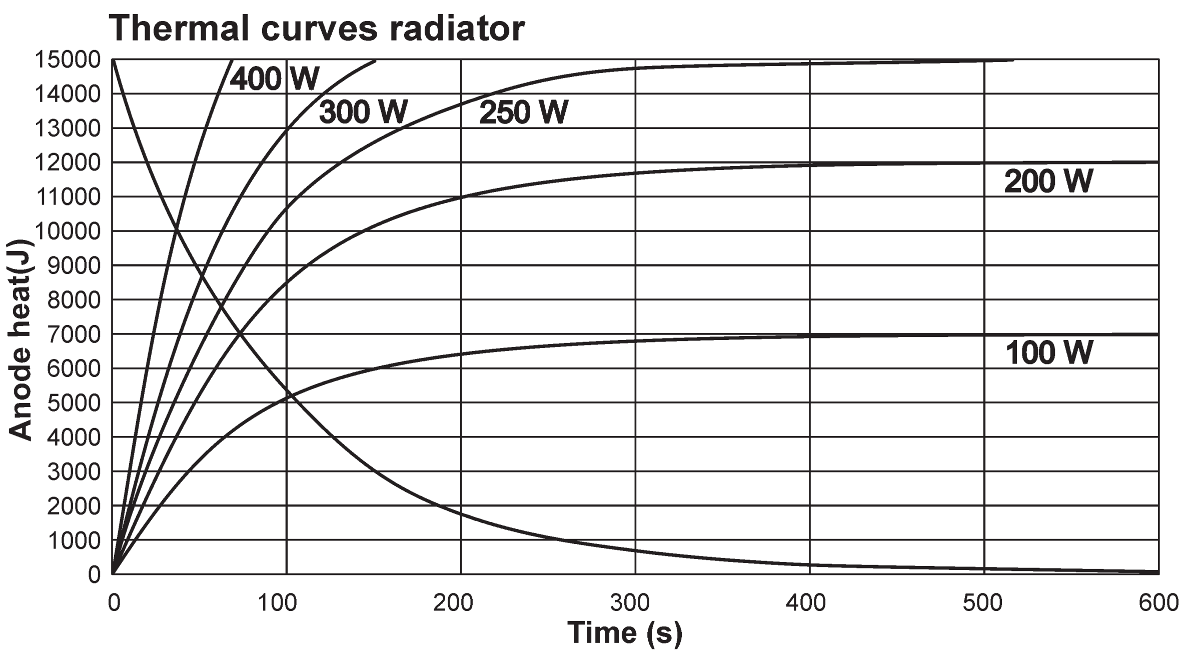
Anode thermal characteristics



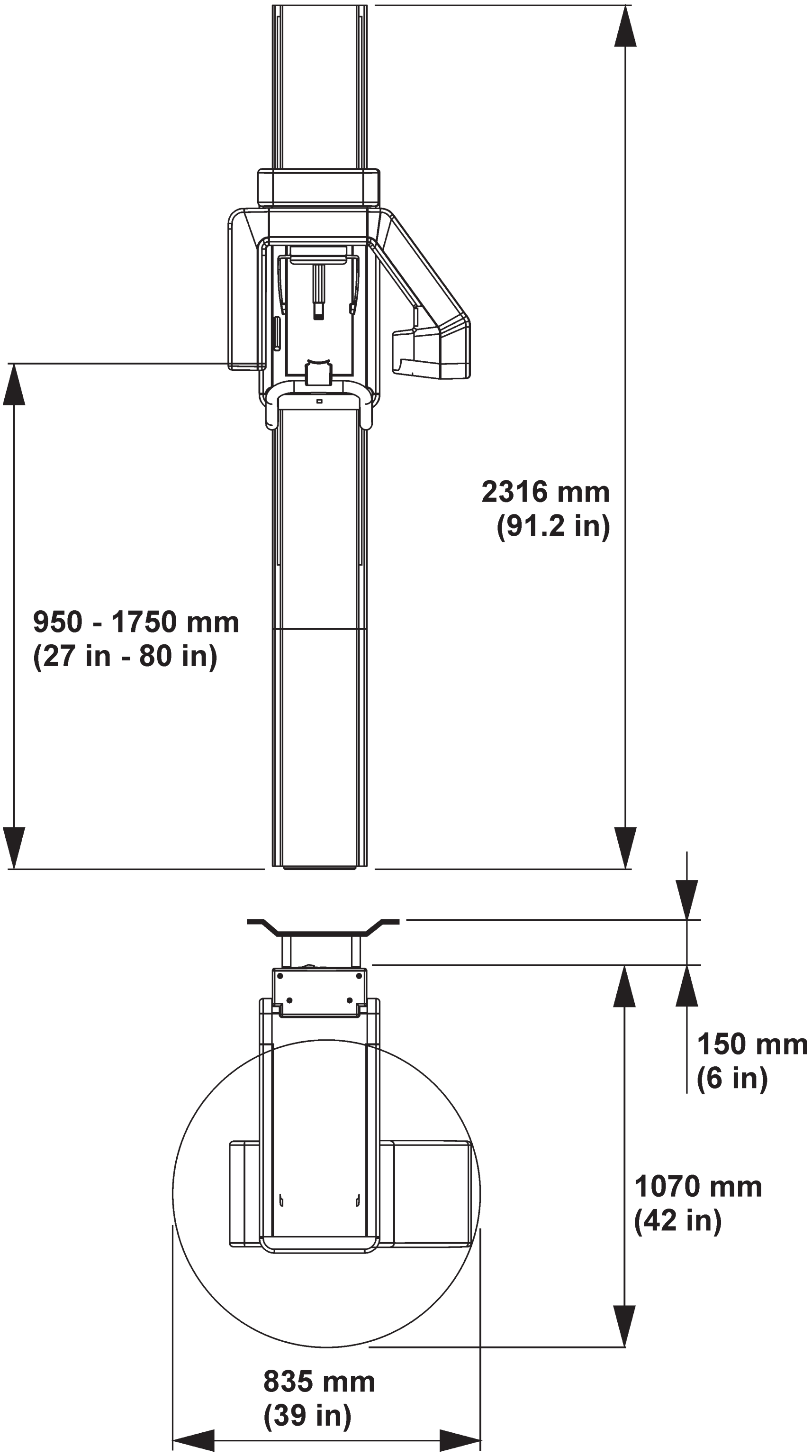
Tube rating chart OX/90



Anode thermal characteristics



A.2 Unit dimensions



A.3 Symbols that appear on the unit


Radiation warning


Dangerous voltage

I On or enabled

O Off or disabled

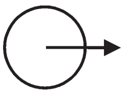

Unlocked (exposure switch)


Locked (exposure switch)


Exposure switch


Connector for Ethernet RJ45


Connector for exposure switch


Connector for external exposure light


Attention, consult accompanying documents

Ground (Functional)

Protective ground

CLASS 1 LASER PRODUCT
EN 60 825-1/A2:2001

Laser class label
(Patient positioning lights)

This symbol indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer for information concerning the decommissioning of your equipment.

Type B equipment

0537

CE (0537) symbol
MDD 93/42/EEC

ETL Classification

CH01

A.4 Electromagnetic declaration

Guidance and manufacturer's declaration – electromagnetic emissions

The CRA-1 is intended for use in the electromagnetic environment specified below. The customer or the user of the CRA-1 should assure that it is used in such an environment.

Emissions test	Compliance	Electromagnetic environment - guidance
RF emissions CISPR 11	Group 1	The CRA-1 uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class B	The CRA-1 is suitable for use in all establishments, including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Complies	

Guidance and manufacturer's declaration – electromagnetic immunity			
The CRA-1 is intended for use in the electromagnetic environment specified below. The customer or the user of the CRA-1 should assure that it is used in such an environment.			
Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment - guidance
Electrostatic discharge (ESD) IEC 61000-4-2	±6 kV contact ±8 kV air	±6 kV contact ±8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30 %.
Electrical fast transients/bursts IEC 61000-4-4	±2 kV for power supply lines ±1 kV for input/output lines	±2 kV for power supply lines ±1 kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±1 kV differential mode ±2 kV common mode	±1 kV differential mode ±2 kV common mode	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply lines IEC 61000-4-11	<5 % U_T (>95 % dip in U_T) for 0.5 cycle 40 % U_T (60 % dip in U_T) for 5 cycles 70 % U_T (30 % dip in U_T) for 25 cycles <5 % U_T (>95 % dip in U_T) for 5 sec	<5 % U_T (>95 % dip in U_T) for 0.5 cycle 40 % U_T (60 % dip in U_T) for 5 cycles 70 % U_T (30 % dip in U_T) for 25 cycles <5 % U_T (>95 % dip in U_T) for 5 sec	Mains power quality should be that of a typical commercial or hospital environment. If user of the CRA-1 requires continued operation during power mains interruptions, it is recommended that the CRA-1 be powered from an uninterruptible power supply or a battery.
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic field should be at levels characteristic of a typical location in a typical commercial or hospital environment.
NOTE U_T is the a.c. mains voltage prior to application of the test level.			

Guidance and manufacturer's declaration – electromagnetic immunity

The CRA-1 is intended for use in the electromagnetic environment specified below. The customer or the user of the CRA-1 should assure that it is used in such an environment.

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment - guidance
			Portable and mobile RF communications equipment should be used no closer to any part of the CRA-1, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. Recommended separation distance
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz	3 V	$d = 1.2\sqrt{P}$
			$d = 1.2\sqrt{P}$ 80 MHz to 800 MHz
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2.5 GHz	3 V/m	$d = 2.3\sqrt{P}$ 800 MHz to 2.5 GHz where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in metres (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey[a] , should be less than the compliance level in each frequency range[b]. Interference may occur in the vicinity of equipment marked with the following symbol: 

NOTE 1 At 80 MHz and 800 MHz, the higher frequency range applies.

NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicated theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the CRA-1 is used exceeds the applicable RF compliance level above, the CRA-1 should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting of relocating the CRA-1.

[b] Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m.

Recommended separation distances between portable and mobile RF communications equipment and the CRA-1.			
The CRA-1 is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the CRA-1 can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the CRA-1 as recommended below, according to the maximum output power of the communications equipment.			
Rated maximum output power of transmitter W	Separation distance according to frequency of transmitter m		
	150 kHz to 80 MHz $d = 1.2\sqrt{P}$	80 MHz to 800 MHz $d = 1.2\sqrt{P}$	800 MHz to 2.5 GHz $d = 2.3\sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.38	0.38	0.73
1	1.2	1.2	2.3
10	3.8	3.8	7.3
100	12	12	23
For transmitters rated at a maximum output power not listed above, the recommended separation distance *d* in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer. NOTE 1. At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies. NOTE 2. These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.			